Proceedings of the 7th International Conference on Economic Management and Green Development
DOI: 10.54254/2754-1169/31/20231542

Analyze the Underlying Problems of Tesla Electric Cars and Other Similar Electric Cars

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Abstract: Tesla, as a globally competitive E-auto manufacturer and enterprise, has established its businesses all over the globe. This study would be disclosing problems and issues now faced by Tesla's products, and products of the entire market of electric cars: slow charging speed, emerging competitors, and low performance of batteries under cold environments. This area of the study is important due to the fact that the sector of electric automobiles is a novel and promising market compared with traditional car manufacturing, this study could enlighten other electric car producers to adjust their products. The study uses researching and analyzing devices such as 4P, Cubic smoothing index, and SMLR. Three problems concluded by this study could be addressed via, first the slow charging speed: the method of circulating high-temperature gas heating. Secondly, to outcompete other brands, Tesla should make their product more price-appealing, and more affordable to more consumers. Thirdly, in order to operate ideally under cold environments, the internal heating method could be used. Nonetheless, due to limitations ground tests could not be done on actual Tesla Models, therefore more research should be done in the future to find out the best way to the situation.

Keywords: tesla, 4P, electric car, batteries

1. Introduction

Although the world's first electric car was invented in 1835 by Sibrandus Stratingh, however, it was not until recent 20 years that the idea of electric cars was well-known and seriously considered by the public.

At the moment, research and advancement in the field of new energy cars in a variety of countries are concentrating mostly on hybrid electric vehicles, pure electric vehicles, and fuel cell vehicles respectively. The pure electric vehicles that Tesla Motors manufactures in the United States are, for the most part, automobiles that are powered by the energy that is stored on board. Vehicles that run only on electricity have been around for more than a century. They feature a number of benefits, including zero emissions, low noise levels, simple architecture, and cutting-edge technology. On the other hand, batteries have a low capacity for energy storage relative to their weight, there is no practical scale available, and their performance is poor in cold settings. Batteries not only store energy but also provide the electricity that is used throughout the entire energy system. They are an essential part of electric vehicles. However, when electric vehicles are operated in areas with low temperatures, the performance of its primary components, such as power batteries and motors, will significantly decline, and this may even lead to power failures that render the vehicle unable to function. The

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performance of pure electric vehicles, such as the Nissan Leaf, Chevrolet Volt, Tesla Models, Tengshi, BAIC New Energy EV series, and JAC New Energy IEV series, in terms of range as well as charging and discharging, is said to be greatly hindered by situations with low temperatures. Batteries have a number of drawbacks, including high production costs, short lifespans, and limited driving ranges, which all slow down their rapid progress. The key to the rapid development of electric vehicles is to break through these limitations as quickly as possible. The exceptional performance of Tesla Motors, which is just one of several automakers, has led to the creation of a peak miracle for the development of pure electric automobiles. Tesla Motors was established in 2003 and named after Nicholas Tesla, who is considered by many to be the "father of electromagnetic physics." Elon Musk, the man who pioneered the electric vehicle, is widely regarded as the "Steve Jobs" of the automobile business. Silicon Valley, in the state of California, serves as the location of Tesla Motors' main office. Its primary activities include of the design, manufacturing, and marketing of all-electric vehicles. In addition, it offers research and development as well as original equipment manufacturing (OEM) production services to third parties for the purpose of producing electric vehicle power systems. Tesla Motors was the first firm in the world to manufacture electric vehicles that used lithium-ion batteries. The Tesla Roadster, Tesla Model S, and Tesla Model X are all examples of the company's automobile production.

This study will analyze the underlying problems of Tesla Electric cars and other similar electric cars. With tools such as 4P, SMLR, and Cubic smoothing index. The target of this study is to guide Tesla and other similar electric car manufacturers to improve their products, by focusing on problems raised in the study, and then making adjustments accordingly by adapting methods introduced in the study. The passage would first discuss the 4P of Tesla Motor, and then analyze the problems of Tesla's and other electric cars and Tesla's pricing problem. Then, suggestions would be given for each problem using research data and data analysis. Lastly, the conclusion of the study would be made and point out guidelines for future studies.

2. Tesla Cooperation Background

On July 1, 2003, Martin Eberhard and Marc Tarpenning established Tesla Cooperation. The business received $7.5 million in series a investment in February 2004, including $6.5 million from Elon Musk. The company's plan from 2005 to 2009 was to launch with a high-end sports car targeted at early adopters and subsequently transition towards more popular cars, such as sedans and cheap compacts. In 2010, Tesla began the first round of Model S production and went public on NASDAQ through an initial public offering (IPO). Tesla quickly rose to prominence as one of the most well-liked electric vehicles of the period, and in 2014 the company unveiled the Tesla Autopilot, a driving assistance system. So far, Tesla has become the biggest company, taking up almost 15% of the market share, in the industry of electric automobiles. Establishing Model S, Model X, Model 3, Model Y, and the upcoming Cybertruck, aiming at customers who are fond of the futuristic style and eco-friendly ways of commuting.

3. 4P Marketing Strategy Analysis

3.1. Product Strategy

Aiming for changing the way how people travel in the future, Tesla's Model S, Model X, Model 3, and Model Y, are all directly pictured, designed, and produced to suit demands that traditional cars that burn fossil fuels could fulfill. All models are equipped with an auto-piolet system to aid or free drivers from operating the car, and with newly designed batteries that have longer mileage and faster charging, Tesla e-autos have the upper hand to compete with any competitors.

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3.2. Price Strategy

When Tesla Model S first came out, it charged up to 150,000 dollars, since that electric automobile was a novelty to the market; few who were willing to try were not concerned about the high price. Tesla adopts a strategy of positioning itself in the luxury goods market to enter the market. The first Tesla Roadster model produced by Tesla was not a simple sedan, but a high-performance luxury sports car [1]. Also, the first released model was produced for a small amount, plus the design fee, it was reasonable to charge a high price. Today, as Tesla's products became more profitable, the price went down; however still obviously higher than its major competitors such as BYD and NIO.

3.3. Promotion Strategy

Instead of giving the franchise to retailers or car dealers, Tesla only creates sale centers that are directly managed by headquarter, which would guarantee the service provided to customers and help to maintain a fair a uniform price. Tesla also provides world-class after-sale service which has helped them to build nice renown and gain customer loyalty. While Tesla's sales channels solely use the self-operated 4S store concept, traditional automakers place more emphasis on a channel strategy that mixes dealers and 4S shops. Tesla has 34 physical stores as of the fourth quarter of 2012, 23 of which were in North America. These distinctively decorated establishments are found on the first floor of sizable high-end malls. There is a platform for showing electric automobiles as well as a giant screen in the middle where customers may create their own unique models. These cutting-edge techniques for sales technology have created a strong market base for Tesla's success [1].

3.4. Placement Strategy

Instead of posing advertisements on TV or on billboards, the co-founder of Tesla: Elon Mask, used his personal influence to promote Tesla, via the internet and social media. On his blog, he would timely release updates and information about new Models and products, to attract potential customers and to keep current customers updated. On the other hand, Tesla also has set up many stores for display in malls and compounds, for customers to personally check, try, and test drive Models.

However, now Tesla is facing some major problems that threaten its future success: the slow charging speed of electric cars, increasing numbers of competitors, and deficiencies in batteries under cold environments.

4. Analysis of the Problems

4.1. The Charging Speed

The charging speed has always been a significant problem for all-electric cars, especially under low temperatures. In low-temperature environments, lithium-ion batteries are difficult to charge, and their negative electrode surface is prone to accumulate to form metallic lithium during charging. The growth of lithium dendrites can pierce the battery membrane, causing a short circuit inside the battery, causing permanent damage to the battery, and causing thermal runaway of the battery, leading to a significant reduction in its safety in use [2]. Research data indicate that the shortcomings such as the deterioration of power characteristics of power batteries and the decrease in coulomb efficiency of charging and discharging caused by low temperatures are one of the objective factors restricting the development and practical application of electric vehicle technology advantages. Unlike traditional cars that could be fueled within seconds, it would usually take at least several hours for electric cars to charge to their full capacity. For example, for Tesla Model 3, it would take 10-12 hours for domestic electricity chargers to charge the car from 0 to 100 percent. There for, in order to be standing

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out from the market and also to compete for customers with traditional car makers, Tesla would have to solve the problem of slow charging speed under both normal and cold environments.

4.2. Competitors

The market share of Tesla is shrinking because of the increasing competition from traditional car manufacturers and new electric car companies. When it was first established, Tesla had less competition since traditional manufacturers were not as aggressive in entering the electric vehicle (EV) industry. The market for electric vehicles is now being invaded by General Motors (GM), Ford (F), Volkswagen (VWAGY), and Toyota (TM), so that is no longer the case.

On the other hand, in China NIO Inc., WuLong electric car company, and in India Electrical Appliance Manufacturing Companies are also joining the market of electric cars. These potential competitors would be threatening Tesla from aspects such as price and technology. As presented in the chart below [3].

Table 1: Comparison between tesla models and NIO model [3].

Models of electric cars	Technology	Price(CNY)
Tesla Model 1S	2 digital screens, an instrument display, and a 17-inch touch screen; Panoramic sunroof; Noise reduction design; Science Motor; auto-piolet system	731,000￥-813,500￥
Tesla Model 1X	17 inch console; Gull-wing doors; surrounding camera; front radar; auto-piolet system	778,200￥-1189,300￥
NIO ES8	NIO voice assistant; All aluminum alloy frame; Front and back motor	407,500￥
NIO ES6	8.8-inch digital screen; Aluminum alloy and carbon fiber car frame; Auto-piolet system	358,000￥-548,000￥

As listed in Table 1, the price of NIO Models is about half of Tesla's and NIO is keep working on improving its technology to match Tesla [3].

4.3. Batteries

Batteries, as the heart component of making an electric car, has a vital problem in that their performance would be greatly reduced under low temperature, especially under sub-zero temperatures.

Batteries' performance would be largely reduced under cold environments. For example, all Tesla E-motors are powered by lithium batteries, a study conducted by the Shanghai Industrial Technology research institution showed that as the temperature decreases, Lithium-ion batteries' charging and discharging performance significantly degrades. The battery's discharge capacity is 87.0% of its discharge capacity at normal temperature and its average discharge voltage is 0.598 V lower when the temperature lowers to - 30 °C; The constant current charging capacity of lithium-ion current is only 14% of the total charging capacity, and the constant voltage charging time increases [4]. Thus, for markets like Russia, Canada, Norway, and countries that are in high latitudes with sub-zero winter temperatures, the problem of the performance of lithium batteries under low temperatures would have to be solved to attract more consumers and compete with traditional cars.

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5. Suggestions

First, the method of Circulating high-temperature gas heating could be installed [5]. This method refers to using air as a medium to directly pass through the power battery module to achieve the purpose of heating the power battery pack. Generally, forced air convection is used, which means that hot air is sent into the power battery box through an external fan or other devices to exchange heat with the power battery. Hot air can be generated by heating pads, and can also be obtained by using the heat emitted by the motor and high-power electronic and electrical heating devices in the vehicle. For hybrid vehicles, the engine can also provide energy to heat the air [6]. This method could effectively heat up batteries to have them charging at their prime.

Second, to be price-appalling, Tesla needs to establish cheaper cars in order to compete with emerging electric car companies such as NIO from China.

Table 2: 2017-2020 electric car sales combined prediction result [7].

Year	2017	2018	2019	2020
Cubic smoothing index	756237	942747	1137228	1347653
SMLR	883645	1006676	1135254	1273430
Entropy combination prediction	838667	984109	1135950	1299631

The combined forecasting results in Table 2 show that the sales volume of electric vehicles in China is still showing a growth trend year by year. Currently, China is vigorously developing the electric vehicle industry, with a broad market prospect. Therefore, the above prediction results are relatively consistent with the development trend of electric vehicles in China [7]. Currently, one of the biggest markets of Tesla: China, had been promoting and subsidizing electric cars greatly through government policies such as Tariff free for low tariffs for electric cars, no need to wait for license plates for electric cars, and no travel restrictions on workdays and holidays. More and more Chinese customers with different needs and purchase power are considering electric cars, for medium and low-income consumers, it is necessary for Tesla, to gain more profit, and to establish cars of lower price to fulfill their needs.

Third, when electric cars are operating under low temperatures. The internal heating method could be used [6]. The power battery is heated internally using the joule heat produced when an electric current flows through a conductor with a specific resistance value. In this case, the conductor is the actual power battery. Low temperatures cause the electrolyte inside the power battery to become more viscous, which restricts the movement of the charge carrier and raises the power battery's internal impedance. The electrolyte may even freeze under severe circumstances. However, taking advantage of the increased impedance of the power battery under low-temperature conditions, the impedance heat generation method can be used to maintain the operating temperature of the power battery [6]. Pesaranl, compared internal heating with air heating and found that internal heating requires less energy and is more economical [8]. According to the positive and negative flow directions of the current, it can be divided into the charging heating method, discharging heating method, and AC excitation heating method [9-12]. According to the different power sources that provide the current, it can be divided into self-loss heating and external energy supply heating [6]. Overall, by using the impedance heat generation method Tesla, including all-electric cars could be operating properly under subzero harsh environments.

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6. Conclusion

This study discussed that for Tesla and other electric car manufacturers, the three problems now faced by them, which are slow charging speed, emerging competitors, and low performance of batteries under cold environments, and gave out possible solutions to each. First, the slow charging speed could be addressed by circulating high-temperature gas heating methods. This method could help the battery to maintain an ideal temperature while charging, under cold or normal temperatures, to prevent the growth of lithium dendrites in order to protect the battery itself and fasten the charging speed. Second, to be able to out-compete other cars, Tesla could, by establishing cars of a lower price, expand its market, and take up the market share of existing cars by fulfilling the demand of customers with medium or low purchase power. Finally, the internal heating method could be installed to guarantee electric cars' function and mileage while operating in cold environments. The power battery is heated internally using the joule heat produced when an electric current flows through a conductor with a specific resistance value. In this case, the conductor is the actual power battery. This paper provided a perspective for Tesla to look at the problems of their product. Findings and suggestions could be giving possible solutions to Tesla cooperation to help them to improve their product and promote sales, and also could also be suggestions to other electric car producers. Nevertheless, over the course of this research due to physical limitations and funding problems, tests could not be done practically on Tesla Models to test out the viability of the solutions hypothesized. Therefore, in the future tests and research could be carried out, for example, by using the internal heating method on a Tesla Model, to test out the enhancement and utility of this method. Accordingly, methods could be improved, changed, or replaced with better once. This research is dedicated to Tesla and all electric car manufacturers, help them to improve the performance of their car and boost sales. Therefore, in the future electric cars would, via enhancements and new technology, become more efficient and economic.

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