Battery Technology-Based Strategic Decisions of Electric Vehicle Firms-The Case of Tesla

Xinyuan Qiao *

Department of Management, University of York, York, United Kingdom

* Corresponding Author Email: Eva.Joeeee@gmail.com

Abstract. Comprehensive support for the electric vehicle industry promotes the development of electrical energy, and R&D in battery technology drives the exploitation of new materials for the planet. Government-enterprise collaboration effectively improves the user experience to ameliorate global warming. This paper elaborates current development status of Tesla based on battery technology (Lithium-Ion Battery), and the latest battery technology (Lithium-Iron phosphate) R&D program. In particular, it reveals whether Tesla follows the theory of strategic market management, its specific strategic decision, sustainability impact on the market, and the trend of the electric vehicle industry.

Keywords: Tesla; Electric vehicle; Lithium-Ion Battery; Strategic Decision.

1. Introduction

The growth and expansion of cities have greatly increased the number of vehicles on the road. Billions of internal combustion engine vehicles are being driven, consuming about 87% of oil or about 33% of global energy [1]. According to a report by the European Union, the transport sector accounts for almost 28% of total CO2 emissions, while road transport accounts for more than 70% of transport sector emissions [2]. Therefore, with increasing environmental degradation, most developed country authorities are encouraging the use of electric vehicles (EVs) and various EVs are being strategically developed worldwide, such as Tesla. As automotive companies navigate this transformative landscape, strategic decisions regarding the integration of battery technologies become paramount.

This research aims to explore the strategic decisions made by Tesla regarding the integration of battery technologies in EVs. The research will involve an in-depth case study of Tesla which has successfully integrated battery technologies in their EVs. This study identifies two main objectives to investigate Tesla's strategic decision to enter the automotive market by adopting battery technology and to assess the impact of Tesla's success on the development of the EV industry. While there is a growing body of literature on battery technologies and EVs, there remains a research gap regarding the strategic implications of these technologies in the automotive industry. The findings can guide industry transformation, promote sustainability, foster business innovation, and inform policymaking in the pursuit of a greener and more sustainable future.

2. Literature review

2.1. Innovation ecosystems

Ecosystems have been of interest to strategists and business sector practitioners [3]. Technology-related is often realized in combination with modularity-related concepts and practical experience. Ecosystems create diverse collaborative relationships, which are recognized as strong relationships between ecosystem participants generating cooperative values.

Ecosystems with conventional technological innovations, such as the Tesla electric car, can reasonably be referred to as innovation ecosystems. Zulkarnain et al. explain the partnerships associated with the EV ecosystem, which in the case of batteries include the battery manufacturer, the component suppliers, and the associated research and development [4]. They address

technological challenges with related companies such as EV manufacturers. Notably, value is created by the sum of participants' contributions, and multilateral collaborations can generate high-quality relationships, services, and products. The obvious point is in the area of lithium-ion battery packs in Tesla's business model.

2.2. Disruptive innovation

Disruptive innovation is defined as emphasizing whether innovative product features, quality, and price can satisfy customer needs by introducing new outcomes into an existing well-established industry that performs better than the existing market. Disruption depicts a complete process in which new entrants aggressively challenge the market position of established companies and achieve incredible success [5]. There are also similar arguments that such disruptive innovations eventually disrupt existing markets replacing established market leaders and alliances [6].

However, Thomas and Maine emphasize that Tesla Motors chooses to target highly prestigious, profitable, and high-performance market segments with new technologies and business models and does not follow a disruptive innovation strategy [7]. Although some argue that it is not disruptive, Tesla, as an emerging EV company that has achieved great success in 20 years, has revolutionized the automotive industry with its business model and strategic plan beyond the traditional internal combustion engine automotive companies, such as Toyota, which was not optimistic about the development of Tesla, is now laying plans to catch up with Tesla in the development of EVs [8]. For instance, Tesla offers different services by intelligently updating the quality of the EVs autopilot by means of Internet innovations. In addition, Tesla is actively investing in battery innovations and mass production of batteries. Disruptive innovation can therefore be considered a new business model with a sustainable impact on the structure of an industry.

3. Battery technologies

3.1. Lithium-Ion Battery (LIB)

Current LIB has been considered the cutting-edge energy storage technology over the past few decades [9]. At present, among all batteries, LIB dominates the battery market for portable electronic products and also has a wide range of applications in the rapidly developing automotive and stationary energy storage markets [10]. The advantages over other energy storage technologies are high energy density, high power density, and long-life cycle. This type of battery is the most common battery used in most electric cars and plug-in hybrids today [2]. For significant characteristics of LIB see Table 1.

3.2. Lithium-Iron phosphate battery (LFP)

LFP has an energy density of about 220 Wh/L, is durable (withstanding 2,000 to 10,000 cycles), and can withstand high temperatures. LFP has been found to be examined in electric cars, for example, researchers at MIT calculatedly decreased its weight and developed a prototype battery that was fully charged in 10-20 seconds. Specifically, Tesla's supporting battery technology route on the car includes 2 types of LFP and high nickel batteries [11]. Table 1 shows the main characteristics of LIB and LFP batteries.

Table 1. Characteristics of LIB and LFP batteries

/	Specific Energy (Wh/kg)	Energy Density (Wh/L)	Specific Power (W/kg)	Cycle Durability	Working Temperature (◦C)	Application
LIB	100-300	200-735	200-3000	400-3000	-20-60	Tesla , BMW, BYD Nissan Leaf
LFP	90-180	220-325	200	2750-12000	/	Tesla

Source: [2], [11],

4. Tesla Motors' strategic decision on the battery technology

4.1. Research Methodology

The particular case study approach is particularly well suited to exploring judgments and understandings about evolving phenomena in an emerging industry, where things are evolving in a society [12]. This paper investigates Tesla's strategic decision to enter the EV sector concerning battery technology, assesses the impact of battery technology on the competitive positioning of the automobile industry, and provides a specific analysis of how it commercialized its EVs so successfully.

In doing so, secondary data from multiple perspectives was collected through company documents, public presentations by the leadership team, news articles, and recently published relevant papers and journals to alleviate concerns about the reliability of the research.

4.2. Findings and analysis

4.2.1 Tesla

In July 2003, Marc Tarpenning and Martin Eberhard founded Tesla Motors ("Tesla") in the U.S. In 2004, Elon Musk joined the company and insists that for Tesla to lead the market, the product must be heterogeneous in order to capture a mature market and incentivize the market to create purchasing power for customers. Tesla is focused on the development of EVs and established a major strategic alliance in 2009 with Panasonic Electronics Corporation of Japan, with battery technology as a key component of electric vehicles, to jointly strengthen battery technology and production capabilities. Thereby attempting to improve the performance, range and reliability of its EVs.

Tesla then gradually shifted to a product strategy for the affordable masses, in addition to focusing on digitalization and adding then revolutionary features such as self-parking and autopilot. As of 2012, Tesla had more than 900 patents, granting free licenses to some of the technology for the public to attract other automakers to the EV industry, additionally, another aspect of the strategy of Tesla is developing distribution and expanding charging infrastructure. Since 2017, Tesla has begun to showcase several new models, and revenues have grown from $117 million in 2010 to $31.536 billion in 2020, and in 2020 Tesla became profitable for the first time. In January 2020, Tesla became the highest market capitalization automaker in the United States [13].

4.2.2 Financial Analysis of Tesla (LIB)

The market entry strategy of Tesla as a new entrant is to utilize expensive new technologies to enter the high-end market. This is because almost every new technology for a new entrant is expensive, to begin with in a mature automotive sector, especially EV-specific technologies, batteries, motors, and inverters. The founders of Tesla Motors avoided the initial capital outlay of building their manufacturing facility by outsourcing the manufacture and assembly of most standard components to specialized manufacturers [14]. Most importantly, Tesla recognized from the beginning that battery packs would be the most critical area of competition, meaning that the corporation with the most advanced battery technology owns the EV market. Panasonic is a leader in technology and scalability, with the highest backlog among battery manufacturers. As a result, Panasonic is considered the preferred EV battery company, and Tesla's strategic alliance with Panasonic is a smart decision.

In the period from 2010 to 2022, Tesla Motor had a net income of $12.58 billion in 2022, after which Tesla's revenue has been growing. From $0.11 billion to $81.46 billion in 2022. This dramatic growth trend has pulled the stock price up, and an increasing number of investors are confident in Tesla. Wherein, Tesla Motor’s stock price was $0.99 per share in July 2010, and by November 2021, its stock price for has reached as high as $414.49 per share. This suggests that the profitability of Tesla's EVs utilizing LIB is a true reflection of its future growth. Similarly, in terms of gross profit, in 2010, Tesla’s gross profit was $0.03 billion and by the end of 2022 gross profit has increased to $20.85 billion.

In terms of net income, during 2020-2019, Tesla's net income has been negative and in the red, but from 2020 onwards, its net income is 0.69 billion and by the end of 2022 it is 1.258 billion. This trend indicates that the market capacity for Tesla's EVs is increasing rapidly [15] (SEC; Yahoo Finance; Investor Relations). See Table 2 and Figure 1 for specific financial analysis.

Table 2. Financial Summary of Tesla

	Net Income	Revenue	Gross Profit
2010	-0.15	0.11	0.03
2011	-0.25	0.20	0.06
2012	-0.39	0.41	0.03
2013	-0.07	2.01	0.45
2014	-0.29	3.19	0.88
2015	-0.88	4.04	0.92
2016	-0.77	7.00	1.59
2017	-2.24	11.75	2.22
2018	-1.06	21.46	4.04
2019	-0.86	24.57	4.06
2020	0.69	31.53	6.63
2021	5.51	53.82	13.6
2022	12.58	81.46	20.85

Source: [15]; SEC; Yahoo Finance Investor Relations

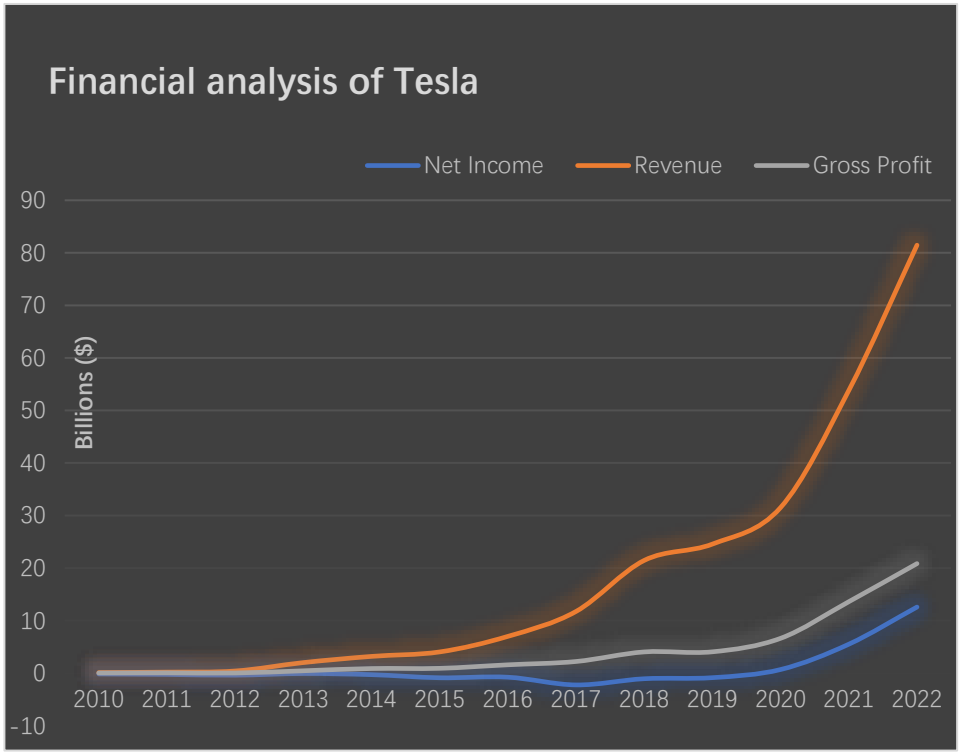

Fig. 1 Financial Analysis of Tesla

4.2.3 Development of LFP and High Nickel battery technologies

Tesla has divided its EV market into 7 categories in Master Plan Part 3, with 2 types of supporting batteries, LFP and High Nickel batteries. Four of the models will be equipped with LFP batteries, as follows:

Compact models (low price), Tesla plans to be equipped with a 53 k/Wh LFP battery, with a target sale of 42 million units.

For mid-size cars, Tesla plans to equip with 75 k/Wh LFP batteries, the target sales of 24 million units.

Buses, Tesla plans to enter the field of electric buses, which will be outfitted with 300 k/Wh LFP batteries, with a target market volume of 1 million units.

For short-range heavy trucks, Tesla plans to equip them with 500kWh LFP batteries, the target sales of 1 million units, the same as the bus sales.

And the remaining three models, Tesla plans to equip High Nickel batteries:

Commercial/passenger cars, and large cars, SUVs, and trucks plan to be equipped with 100k/Wh High Nickel batteries, with target sales of 10 million items and 9 million units, respectively.

Long-range heavy trucks, which will be outfitted with 800 k/Wh High Nickel batteries, with a target market volume of 2 million units.

It can be seen that Tesla has shown the value of exploring LFP batteries in Master Plan Part 3. Meanwhile, High Nickel batteries are planned to be utilized in the higher-end model market. The strategic decision of Tesla to use different battery technologies in different types of EVs will achieve the goal of fully capturing both the low-end and high-end EV markets [11].

Governments around the world are beginning to support the development of EVs. For instance, Mercedes-Benz, BMW, and Volkswagen are supported by the German and Chinese governments, respectively. Global warming concerns are growing, Google, Apple, Facebook, and Amazon have also developed ambitions to invade the automotive industry, and Toyota is finally responding to the expansion of the EV industry. In terms of global EV sales in 2021, Tesla is ranked No. 1 (936,172), BYD is No. 2 (593,878), SGMW is No. 3 (456,123), Volkswagen is No. 4 (319,735), while Toyota is No. 16 (116,029) [8]. See Table 3.

Table 3. Worldwide Sales of Selected EVs

Year	Brand	Units	Rank
2021	Tesla (USA)	936,172	1
2021	BYD (China)	593,878	2
2021	SGMW (China)	456,123	3
2021	Volkswagen (Germany)	319,735	4
2021	Toyota (Japan)	116,029	16

Source: [8]

KAWAI explains that Toyota believed that purely EVs would never be accepted by consumers due to the short range, expensive batteries, and high electricity usage. Toyota used to see Tesla as a non-threat, however, Tesla has become a true first mover. Tesla's huge success to date and its innovative business model has led Toyota to actively take strategic decisions to catch up with Tesla in the EV market. Toyota, with its abundant resources and strong technical support, is fully developing solid-state batteries and attempting to be the first company to introduce such batteries. Toyota is in the stage of actively looking for joint ventures, for example, Toyota announced partnerships with CATL, BYD, and TOSHIBA; an agreement with BYD on a joint venture to develop EVs; and an announcement of a joint investment with SUZUKI and SUBARU. Tesla has become a leader in the EV market based on the development of LIBs, an important component, which has driven various world brands to enter the EV market, which not only effectively combats global warming, but also makes a disruptive change in the automobile market [8].

5. Conclusion

The impact of global warming has led governments to support the full development of EVs, this paper investigates Tesla's market strategy, illustrates the strategic management theory of innovation ecosystems and disruptive innovations; clarifies that Tesla creates product value with a system of networks of its key stakeholders including the battery pack sector. LIBs that Tesla utilized with superior technical specifications, ultra-high sales, and years of financial data demonstrating consumer

support and positive future trends. Meanwhile, the development of new battery technologies (LFP & High Nickel batteries) and the planning of various vehicle models show Tesla's ambition to capture the EV market. Its new products and business model have disrupted the existing automotive market, having a sustainable impact on the EV industry. Furthermore, automotive companies are making great efforts to develop EVs, and technology companies' plans to enter the EV field have led to further exploration and development of battery technology. Although this paper lacks an analysis of the safety and effectiveness of battery performance, practical consumer research, it can be a guiding contribution to new market entrants, business innovators, and relevant policymakers.

References

[1] Sun, P.; Bisschop, R.; Niu, H.; Huang, X. A review of battery fires in electric vehicles. Fire technology, 2020, 56: 1361-1410.

[2] Sanguesa, J.A.; Torres-Sanz, V.; Garrido, P.; Martinez, F.J.; Marquez-Barja, J.M. A review on electric vehicles: Technologies and challenges. Smart Cities, 2021, 4(1): 372-404.

[3] Dhanaraj, C.; Parkhe, A. Orchestrating innovation networks. Academy of management review, 2006, 31(3): 659-669.

[4] Zulkarnain.; Leviäkangas, P.; Kinnunen, T.; Kess, P. The electric vehicles ecosystem model: Construct, analysis and identification of key challenges. Managing Global Transitions, 2014, 12(3): 253.

[5] Christensen, C. M.; Raynor, M. E.; McDonald, R. What Is Disruptive Innovation? Harvard Business Review, 2015.

[6] Deshmukh, A. A.; Bhalerao, V. R. Disruptive Innovation: Opportunities and Challenges Introduction. SaiBalaji International Journal of Managemetn Sciences II (IV). 2019.

[7] Thomas, V. J.; Maine, E. Market entry strategies for electric vehicle start-ups in the automotive industry–Lessons from Tesla Motors. Journal of Cleaner Production, 2019, 235: 653-663.

[8] Kawai, T. Evaluation of Toyota's Strategy for Electric Vehicles in Counteracting Platformers—Based on the Theories of Dynamic Managerial Capabilities and Dynamic Platform Strategy. Journal of Strategic Management Studies, 2022, 14(1): 67-87.

[9] Ramdhan, R.A.F.; Ekaristianto, H.M.; Goenawan, Y.D.; Mubarok, M.W.S.U.; Fakhrudin, M.; Kartini, E.; Drew, A.J. Analysis Study on Scaling Up Production of Lithium-Ion Batteries (LIB) Cathode Material at National Battery Research Institute. Journal of Batteries for Renewable Energy and Electric Vehicles 2023, 1(01): 14-22.

[10] Duffner, F.; Kronemeyer, N.; Tübke, J.; Leker, J.; Winter, M.; Schmuch, R. Post-lithium-ion battery cell production and its compatibility with lithium-ion cell production infrastructure. Nat. Energy, 2021, 6: 123–134.

[11] Tesla. Master Plan Part 3 Sustainable Energy for All of Earth, 2023. Available: https://www.tesla.com/ns_videos/Tesla-Master-Plan-Part-3.pdf. (accessed on 1 August 2023)

[12] Eisenhardt, K. M. Building Theories from Case Study Research.The Academy of Management Review, 1989, 14(4): 532.

[13] Braunfels N S J. Tesla Motors: Disrupting the automotive industry[D]. Universidade NOVA de Lisboa (Portugal), 2021.

[14] Baer, D. The making of Tesla: invention, betrayal and the birth of the roadster. Business insider,2014.Available:https://www.businessinsider.com/tesla-the-origin-story-2014-10(accessed on 3 August 2023).

[15] Shao X, Wang Q, Yang H. Business Analysis and Future Development of an Electric Vehicle Company--Tesla. 2021.