Innovation model analysis of new energy vehicles: taking Toyota, Tesla and BYD as an example

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Abstract

As one of seven strategic emerging industries, new energy vehicle industry has great significance in China's economic growth and environmental protection. In this paper, taking Toyota, Tesla and BYD as examples, innovative models of new energy vehicles are analyzed. The paper analyzes and compares mainly innovation of the ecological environment, market positioning, innovation path and business model, drawing the following conclusions: Toyota adopted innovative symbiosis strategy that by the use of complementary resources of global relevant enterprises, it made optimized configuration in the global, and built enterprise ecosystem to make progressive disruptive innovation and develop the middle and low-end market; Tesla in a better environment for innovation among the best in the world standing on the forefront of technology innovation environment, quick disruptive innovation, the first to lead the high-end demand, and then to low terminal extension is Tesla's business model. BYD in Shenzhen, a good ecological environment of innovation, through cooperation with domestic and foreign, to niche-based, open platform for product innovation is formed by a plurality of core technologies capture gather after the adoption of the platform innovation resources in connection with the comprehensive remodelling expansion, continued low-cost, high-strength, integrated, open innovation, products are mainly targeted at low-end market.

1. Summary of new energy vehicle innovation model

The United States studied mainly from the industrial theory and policy, and focused mainly on electric vehicles
and hydrogen fuel cell vehicles. Fred Joseck, the U.S. Energy secretary, on the basis of generalization and summation of the special plan for hydrogen fuel cell vehicles and electric vehicles, thought that although there were some questions on research projects as well as the main direction of development of new energy vehicles in the United States, it gradually form development pattern that took the enterprises as the main part and government supported mainly \[1\]. Hasishi Ishitani, from the perspective of policy system, the overall strategy and the strategic objectives, researched Japanese hybrid electric vehicles and thought that Japan basically formed a development system of new energy vehicle which guided by the government and participated in by the whole society\[2\]. In our country, the scholars mainly studied the innovation ability evaluation, patent analysis, government policy support, etc. of new energy vehicles. Liu Lanjian and Chen Shuangbo based on analysis of Chinese new energy vehicle technology innovation policy, proposed new energy vehicle innovation model which was based on multi-loop competition, analyzed several ways to promote the advancement of technology, and proposed the policy system of supporting multi-loop competition model system implementation \[3\]. Wang Zhiqi et al. taking hybrid vehicles as an example, with patent data in 20 major technical fields as samples, using the method of input-output analysis identified the field of forward technology and core technology, and analyzed the development trend of key technology areas \[4\]. He Zhengchu et al. established evaluation model based on analytic hierarchy process (AHP) and fuzzy evaluation method, evaluated and analyzed selectively the development of new energy vehicles industry in Hunan Province \[5\]. Chen Zhaofeng believed there were some problems on our strategic emerging industries, including Low-end links excessive competition, low accumulation capacity to independent innovation and overly participating by the government and so on and thought that by the Global Value Chain (GVC) value chain model to the countries in transition and the forming GVC NVC high-end competitive advantage were important strategic innovation of Chinese strategic emerging industries \[6\]. Liu Jianhua and Ji Zhanghua taking Henan Province as an example, built evaluation index system of traditional industry innovation driven, transformation and upgrading, and constructed an analytical framework and innovation strategies of strategic emerging industries patent technology\[7\]. This paper studies from the perspective of the new energy vehicle innovation patterns, and analyzes innovation of the ecological environment, market positioning, innovation path and business model of Tesla, Toyota and BYD which are representative new energy auto enterprises of U.S. Japan and China.

2. Illustrations

The world economy has entered a post-crisis era, the strategic emerging industries has become a powerful engine to achieve industrial restructuring. Wu Hang, from the perspective of innovation ecosystems, explained the meaning of the ecosystem, and from three aspects of innovation cluster development, collaborative innovation, and ecological environment construction proposed the development of strategic emerging industries \[8\]. Li Lei, Guo Yanqing through the analysis of new energy vehicles in the United States, Japan and Europe's development, pointing out that China's development of the urgency of the task of new energy automotive industry, the primary task of the development of new energy vehicle industry is innovation, combined with the theory of innovation ecosystem constructing new energy automobile industry innovation ecosystem model, and carried on the comprehensive analysis \[9\].

The automotive industry is a global technology and capital-intensive industries, product development and investment in fixed assets is very large, significant economies of scale. Toyota currently has 50 manufacturing facilities in 27 countries and regions around the world, and more than 160 countries worldwide car sales. This provides conditions for the integration of the global Toyota's new energy vehicle innovation resources, Toyota created a good innovation environment by the way of cooperating with local universities, enterprises and research institutes to establish research institutions in various regions, or by other ways. Toyota motor vehicles jointly Nissan, government agencies, foreign enterprises and other domestic and foreign institutions set up the Japanese electric vehicle alliance. Taking the Toyota in the United States as an example, Toyota and GM Group worked on automotive safety research together, and spend billions of dollars establishing The Research Institute (TRI) in the United States, Toyota Research Institute and Stanford University, Massachusetts Institute of Technology and the University of Michigan in cooperation to develop the automatic driving technology and artificial intelligence research. Starting from the enterprise business processes, the research and development, sales and service in the global scope of the optimization of the allocation, to build innovative symbiotic strategic ecosystem.
Tesla as a high-tech company without any background in the automotive industry, only used more than ten years time to become one of the world's top ten innovative companies in the vehicle manufacturing industry. The reason is that Tesla is in a better innovation environment, Tesla is headquartered in Silicon Valley, California area. In Tesla's team, the most important members is Elon, he gave the team Internet genes; The second is Black, who was an former executive of the Apple Corp, but now he is the Tesla user experience executives, mainly responsible for the user experience; Another is Tesla CTO, responsible for the technology in the aerospace industry grafted to Tesla Motors manufacturing process. Thinking with Silicon Valley, to create a Silicon Valley team to build cars, the high degree of homogeneity of the car competitive in mature industries to achieve disruptive innovation. At the same time in order to promote the development of electric vehicle technology, Tesla shared all the Tesla's patented technology with other companies; it promoted the development of the new energy vehicle industry innovation environment.

BYD is a set of IT, automobile and new energy technology industry as one of the three major high-tech enterprises. In the new energy vehicles, BYD is one of the forefronts of the world which relies on product and technological innovation, and is one of China's own car brand leader. BYD Academia Sinica built in Shenzhen, which is the city of technology, innovation and industrial centre. BYD has certain advantages in the new energy vehicle batteries, motors, electronic control and other core technologies. General Chinese and foreign joint ventures, the Chinese side to the market for technology, and BYD is a technology for technology, to take their own batteries, motors, electronic control and other technology for Germany on the one hundred years of manufacturing experience and technology. In addition, BYD cooperated with the United States general motors, Chrysler and other international giants, to further enhance its technical level and international brand influence, and signed a cooperation project of electric vehicles with Daimler-Benz in 2010, researched of new energy vehicles cooperation with Intel in 2011. BYD always adhere to the "technology is king, innovation-oriented" concept of development, and continue to devote them to study the accumulation of new energy vehicle technologies, it considers technological innovation as DNA to achieve a qualitative breakthrough by accumulation, enhance the competitiveness of enterprises.

3. Comparative market positioning

Li Fei, Liu Qian by constructing a diamond model of competitive positioning strategy for a company, think market positioning should follow the development of the strategic positioning of the program, programming dimension of each specific steps needed to complete the core task, the task dimension of each specific initiatives involved the 4P category three dimensions, and test the theoretical advantages of model and the use of guidance in marketing practice [10].

Toyota, Tesla and BYD’s success has profound truth, due to the entire electric vehicle infrastructure construction, charging time is still too long and also customers habits counts, pure electric vehicles using in family is not mature. But now there are two segments of the market is relatively easy to break, one is the luxury car market, the other is public transportation field, Tesla like to stand in the preface to the era of early adopters, BYD has to attach importance to environmental protection and deal with the problem of air pollution. Tesla has an outstanding design style, interior materials are more luxurious, positing in high level luxury and brand car, catering to double demand of richer, the pursuit of high quality and the demand to try new things. Tesla positioned in the luxury car market, as a result they obtain rapid success in sales, but its disadvantages are also very obvious, the proportion of the rich is too low, so that the overall sales are limited. All over the world are very strong, especially in the field of public transport. BYD is a leader in new energy vehicles in China, located in the field of public transportation. At present, main products are K9 electric bus and E6, BYD aim to launched the two models in main public transportation, the former as energy saving and environmental protection bus into the bus system which is very popular and the other with 300 kilometer of pure electric endurance and good riding space serve as taxi is undoubtedly the most appropriate energy saving and environmental protection. Toyota's main hybrid pushing car, is the best world's hybrid technology car and even the top of the new energy technology expert. Hybrid power is not only a buffer for the pure electric technology, more important is that he changed the way in people using car, and energy acquisition, etc. Toyota has launched compact, medium, large, SUV, as well as a variety of commercial and other forms of hybrid models. Quickly occupied the market, in 2014, the global cumulative sales of Toyota hybrid vehicles reached
7 million, and now Toyota is also committed to fuel cell vehicles, pure electric vehicles and other models. Whether it is a high-end positioning of the Tesla, BYD commitment in the field of public transport and low-end car or Toyota's quickly to occupation of the market rely on the hybrid vehicle, and at the end they will cut into the ordinary home market, the competition and cooperation will be exist among enterprises.

4. Comparison of innovation

Technological innovation is the driving force for the development of new energy vehicles. Xie Zhiming et al. according to scenario analysis, patent analysis and TRIZ technology evolution route analysis of China's new energy vehicle industry market demand, industry development goals and research and development based on qualitative scenario analysis; and use technology patent map analysis China's hybrid vehicles, pure electric vehicles and fuel cell vehicles the three main types of new energy vehicles patent information analysis, on the basis of this, according to the theory of TRIZ technology evolution summary new energy vehicle technology evolution path[11]. Pang Deliang, Liu Zhaoguo from the new energy vehicle technology patent applications as the first step, using of patent cross-comparison of international standards to analysis Japan's new energy technology, it is showed that Japan's new energy vehicle technology is in the world leading level[12].

Tesla turned out in Silicon Valley, with a new way to think about, design, manufacture and operation of vehicles, from luxury cars to make drawings into reality. Standing in the intersection of science and technology, cars, energy, Tesla conducted subversive thinking and research and development about the new energy vehicle. Tesla is the only one using batteries 18650 ternary lithium-ion battery electric car company; in the motor, which uses a dual motor all-wheel drive; in the body, which uses an aluminium body, has become North America's only using aluminium body of the car; in terms of security, the Tesla Model S is the only European Euro NCAP and US high-speed Road Safety Authority dual star-winning car. Tesla take three-step technical route, there are as follows:

The first stage: To release the super-rich high-priced, small mount cars. The price is high when launched the first product, but to ensure that high-end positioning of the car, to make it worth the money. At this stage launched Tesla Roadster.

The second stage: In the middle to high-end price to more relatively affluent consumers to launch medium price, medium volume production of electric vehicles. With the profits obtained by the first stage, developing the car of the second stage. The second phase of the car is still more expensive, but its competitors are more like priced $75,000 Mercedes-Benz or BMW, instead of Ferrari. The aim is to increase public acceptance of electric vehicles, Tesla launched the Model S and Model X. This is also the stage Tesla is experiencing.

The third stage: To launch low-cost, mass production of cars to the general public. Through the second stage to obtain profits and the accumulation of experience, research and develop more economic, more mass production mass of electric vehicles, the relatively cheap price and maintenance savings, so that the middle class can afford. This stage is to encourage more traditional automobile manufacturers to invest in the electric car project, to stimulate competition, to promote the whole industry towards the direction of sustainable development. Tesla will launch Model 3 in the third stage, and the price is likely to be only about $35000.

Due to the lack of energy in Japan, Japan in the energy conservation, new energy technology research and development and industrial investment in a large amount of money in order to maximize the reduction of fossil energy dependence. Japanese car enterprises committed to the development of light weight and low energy consumption, Toyota as Japan's largest car companies, in hybrid cars, in research and development of plug-in hybrid electric vehicle, pure electric vehicles and fuel cell vehicles at the forefront of the world. At present, Toyota's hybrid car sales in the world's first position, the development of pure electric vehicles and the pace of industrialization is the fastest, fuel cell vehicle industry is also the world's leading. Toyota over a long period of development and application of new energy vehicles, has mastered the advanced of new energy vehicle technology, formed a very mature new energy automotive industry, established a fairly complete charging infrastructure, the new energy vehicle development path can be summarized as: The fuel diversification, the comprehensive development of pure electric vehicles, hybrid vehicles and fuel cell vehicles, pure electric mainly for close and small family, as a normal hybrid vehicle for the average family car, commercial fuel cell vehicles for long distance transport. At the same time, Toyota developed an overseas expansion strategy, which can achieve the development of new energy vehicles in the localization. For example, in North America, Toyota's car sales in the United States, approximately 70% by the
Toyota assembly plant in the United States, Canada and Mexico. At the same time, set up research and development centres around the world to understand the needs of different consumers, which is a major component of the development of Toyota's overseas strategy.

In China, the key core technologies is the main problems that restrict the development of new energy vehicles, including: battery and management systems, motor and control system, power system integration as well as charging infrastructure and other facilities. BYD is started from the battery to do, so in the field of batteries, BYD is in the industry leading position, but there are also some problems which need to be improved, such as the short battery life, charging time is long and so on. BYD officially entered the field of automobile manufacturing and sales in 2003 began to develop the process of national brand car. Today, BYD has been built four industrial bases, for example, Xi’an, Beijing, Shanghai, and Shenzhen. In vehicle manufacturing, model development and other aspects, which have reached the international advanced level. China announced a technical line of new energy vehicles in the next decade in 2015, which is the development of new energy vehicles have an important role in promoting. BYD has a solid foundation in core technology development and other aspects of the battery, its main technical route are: recent battery and vehicle integration technology, through independent research and development, technical cooperation and the introduction of new energy vehicles to overcome the absorption of important technology to promote public transportation, and to give the country more people understand and correct understanding of the new energy vehicles; and then post capture the core technology to achieve international level, development of pure electric vehicles, fuel cell vehicles is the main task, open the domestic market and overseas marketing.

BYD is China's leading car brands; it is in the advanced level in the field of battery. Evolution of BYD new energy vehicles innovation ecosystem experienced the following three stages: niche, open platform, the full expansion. Niche refers to BYD new energy automotive innovation ecosystem is a minimal and complete technology system based on ET-Power of power battery technology and traditional fuel automobile manufacturing technology transfer and grafting. Open platform is BYD for core enterprise, to the lithium iron phosphate battery technology, drive of permanent magnet synchronous motor technology, distributed battery management technology key module of core technology for new energy vehicle product innovation platform, and thus attract multiple components, supporting enterprises to participate in innovation, in order to launch a hybrid, pure electric technology series of electric vehicle products, to provide users with diverse choices. The full expansion is that BYD from different target markets and different application scope of implementation of new energy automotive innovation technology and supporting technology depth fusion, pioneered the development of environment and supporting facilities, perfect mature with a higher degree of developed countries market, and then expand to global market and application scope gradually expanded to multiple areas of public transportation, leasing, commercial, logistics and other fields. BYD in Shenzhen, a good ecological environment of innovation, based on Niche (a minimal and complete technology system based on ET-Power of power battery technology and traditional fuel automobile manufacturing technology transfer and grafting) to form an open product innovation platform through the capture of a number of key core technology, and then conduct a comprehensive development, low-cost integration of innovation by the innovation resources of connection and reconstruction platform. The product is mainly located in the low-end market.

5. Business model comparison

Tai Mosi defined business model refers to a complete product, service and information flow systems, including each participant and the role it plays, and each participant's potential benefits and the corresponding revenue sources and methods. Generally speaking, business model innovation is an enterprise with new and effective ways to make money. The three necessary conditions for the innovation of business model are [13] :

(1) Offer new products or services, open up new areas of industry, or provide an unprecedented way of existing products or services;

(2) There are at least a number of elements in a business model that are significantly different from that of others, but not a small difference;

(3) Have a good performance, reflected in the cost, profitability, unique competitive advantage and so on.

Japan, represented by hybrid vehicles in the world have been commercialized, Toyota hybrid car sales in the
world more than 700 million, with the same or even stronger than the traditional car. The success of the Toyota business model mainly in the following aspects:

(1) People oriented, good quality. Toyota car from the appearance to the inside of the accessories are all selected excellent material, and even into the U.S. market is taking into account the American figure in the United States to redesign the body of the car space. So that Toyota quickly in the United States to establish a high quality reputation.

(2) Service quality, customer satisfaction is high. One of Toyota's sales strategies is to seek the implementation of management, service and spare parts supply integration, quality of customer service to dispel concerns about the use of Toyota. Customer satisfaction can be greatly influenced by word of mouth, and it also affects the customer's loyalty to the product.

(3) Brand effect projection. Toyota multinational manufacturing enterprises through the pursuit of quality, insist on customer satisfaction in the first place to consider, from the shape of the "Made in Japan" in the big brands to have international influence and visibility.

Advantage of Toyota's new energy automotive business model is: good quality, fine workmanship, excellent service, to meet the personalization and customization of production, low prices; drawback is poor security, excessive saving reduces the quality of the material; also face the impact from the global automotive market is highly competitive, international relations.

Tesla's success stems from its unique business model, to subvert the traditional perception of customer cars, to solve the safety, mileage short questions, for customers to create an excellent customer experience.

(1) Accurate customer orientation. Precise customer orientation and to meet customer demand stealth, maintaining the value of the business model is the first condition of success. First, developed high-end, high performance sports car, to attract the first group of target customers - concerning for the environment of high earners, focusing on public image of celebrities; the second step is the development of prices close to Mercedes-Benz, BMW and other luxury brands of electric car; the final price can be accepted by the public, can be large-scale promotion of low-cost economics of electric vehicles.

(2) Extraordinary capital operation. The innovation of business model needs to continue to invest large amounts of capital; many vendors provide Tesla's commercial credit for its complements to produce large amounts of funds, long-term leasing, outsourcing of production, direct orders for Tesla stock, a substantial decline in long-term assets. In addition, Tesla also through IPO, to strategic investors and partners to issue preferred shares, common shares, by the new US Department of Energy's Advanced Technology Vehicles Manufacturing projects Tesla acquired a large number of long-term assets.

(3) Light asset management. Tesla did not build large-scale fixed assets, or only constructed a small amount of proprietary fixed assets, mostly for production using other company's resources through outsourcing or leasing and other forms, and itself is focused on high value-added sectors of the development, marketing and terminal channels. Tesla concern with the battery and electric motor technology to control, while the original battery outsourced to a strategic partner Matsushita Electric.

Tesla's new energy automotive business model has to high-end lead consumption, in order to stimulate consumption of the brand advantage, the advantage of experiential marketing and e-commerce sales model, but also faced with inadequate supporting charging infrastructure, government policy support is difficult to obtain threat.

BYD's initial stage has chosen to enter the field of public transport, taking a combination of E6 and K9 implementation of public transport priority strategy, which would be to set up a taxi joint venture, "zero Yuan car" and the construction of different places. The core point of BYD's business model is to let more people can afford to buy them in the short term electric vehicles, and then enlarge the sales of electric vehicles. BYD provides consumers with a more convenient financial operating model of the loan cooperating with the bank.

(1) Lease financing model. Lease financing model is that financial institutions from BYD Company to buy electric cars, and then lease it to the taxi companies, taxi companies to pay rent to the financial institution, after the expiration of the lease ownership of the taxi from financial institutions transfer to the taxi company. The model of the taxi company’s credit quality requirements is higher.

(2) Business leasing mode. Operating lease model is by the car rental company from the financial institution loans to buy BYD's electric car; then, taxi companies and car rental companies operate taxis lease and pay rent; finally, car rental companies take taxi company of paying the rent to repay the loans of financial institutions, and car ownership is owned by car rental companies in the whole process. The model for qualifications taxi company credit
requirements is relatively low.

(3) Buyer's credit model. Buyer's credit model is directly from the financial institutions of the taxi companies to buy BYD's electric vehicles, then, the taxi company to repay the instalment loan. In the process, the car ownership belongs to the taxi company. The model is mainly aimed at the purchase of a one-time purchase of electric vehicles to provide solutions to the taxi company.

BYD new energy vehicles, the advantage of this financial operation mode is to solve the taxi company to buy a one-time vehicle funding pressure. BYD collaboration with the Power Grid Corp are responsible for charging facilities construction, BYD is responsible for vehicle maintenance and repair, and to lift the worries taxi companies and drivers of new energy vehicles in use.

6. Summary

This article carries on the detailed comparison and analysis to the four aspects of the new energy vehicle innovation model which is represented by Toyota, Tesla and BYD, and obtains the following conclusion:

(1) Innovative ecological environment. New energy automotive industry as a new high-tech industry, the development of its technology, especially with the battery, motor and electric control as the representative of the core technology development, has a greater role in promoting the development of the entire industry. The main task of development of new energy vehicles is innovation, and good ecological environment has a positive effect on the innovation of enterprises .Utilizing the advantages of the global related enterprises resources, through the technology in exchange for technical methods, and actively cooperate with universities, research institutes and other research institutions, to create a good environment for innovation and innovation.

(2) Market positioning. At present, new energy vehicles in the promotion period. People lack of awareness of new energy vehicles, and for the car habits, energy acquisition methods are required for a transitional period. Therefore, suitable for the moment to take a break through in the field of public transports, and gradually opens the market. And then, according to the target population to take appropriate price competition after people have a correct understanding of new energy vehicles.

(3) Innovation path. Tesla subversive innovation has a certain effect, and Toyota can achieve win-win with symbiosis strategy. But the new energy vehicles and the traditional automobile technology standards are different. Only master enough technology in new energy vehicles can automobile enterprises achieve long-term development. Therefore, BYD's three stage is more suitable for the current situation of the development of new energy vehicles.

(4) Business model. Business model innovation will be the key to the development of new energy automotive industry. Mature business model should be the mode what is formed in the long-term running between all sectors of new energy automotive industry chain and inter-market. New energy infrastructure can’t be separated from the support of the government, the development of core technology of new energy vehicles can’t be separated from the enterprise, and sales model can’t be separated from the operation of enterprises. Therefore, we should establish a government-led new energy vehicle development business model which is based on research and development of enterprises and separation enterprises.

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