Analysis and Comparison of Technological Innovation in New Energy Vehicle Battery Industry

Muxun Bao[1*] and Qinghui zhang[2]

[1] School of Economics and Management, Lanzhou University of Technology, Lanzhou, China
[2] School of Economics and Management, Lanzhou University of Technology, Lanzhou, China

* baomx@lut.edu.cn

Abstract. With the rapid development of economy and society, energy depletion and environmental pollution have attracted more and more attention. At the same time, with the in-depth implementation of the country's sustainable development strategy, major auto companies have taken new energy vehicles as a new research focus and strategic field, and battery technology as a power source for new energy vehicles has also become a competitive support from countries around the world. Based on the patent data of new energy vehicle battery technology, the social network analysis method is used to analyze the evolution trend of new energy vehicle battery technology. A comparative study of collaborative innovation models in Korea and other countries has been conducted. Suggestions for the development of the country's new energy vehicle battery industry include: increasing investment in scientific research and creating advantageous areas; improving research and development level and participating in international competition; accelerating collaborative innovation and building a perfect mechanism; establishing patent early warning and enhancing intellectual property protection.

Keywords: New energy vehicle battery; Technological innovation; Social network analysis; Collaborative innovation model; International comparison.

1 Introduction

On the basis of judging the development status and characteristics of new energy vehicle batteries by using patent data of new energy vehicle batteries, this paper analyzes the R&D trend of new energy vehicle batteries by using the change of total patent data, and explores the life cycle stage of the current new energy vehicle battery field by using the technology life cycle theory. At the same time, it makes in-depth excavation and comparative analysis on the innovative modes of new energy vehicle battery technology, and explores from multiple dimensions. This paper analyzes the R&D direction, development field, market competition and international influence of new energy vehicle battery technology, and puts forward the countermeasures for the defects and deficiencies of China's battery technology in combination with the national conditions, so as to provide scientific reference for the technical development of China's new energy vehicle battery industry. The marginal contribution of this paper lies in: based on the

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patent data of new energy vehicle battery technology, using social network analysis method, analyzing the evolution trend of new energy vehicle battery technology, and comparing the collaborative innovation modes of China's new energy vehicle battery industry with those of the United States, Germany, Japan, South Korea and other countries from the perspective of open innovation. Finally, the countermeasures are put forward from the perspectives of enhancing the level of industrial alliance cooperation and R&D innovation.

2 New Energy Vehicle Battery Technology Application Issues

2.1 Safety Issues

Based on the analysis of the configuration of new energy vehicle products, it is necessary to ensure both the driving ability and the driving safety and stability. In the past, the new energy vehicle battery technology problem faced by enterprises was that it was difficult to effectively control the safety of power batteries with high battery life; the battery life with better safety was difficult to meet the requirements. For such problems, the emergence of ternary lithium batteries effectively solves the problem of both safety and battery life. The battery stability is not perfect, but the battery life is very strong. The current mainstream is the soft pack battery, which makes up for the lack of stability of the ternary lithium battery [1].

2.2 Endurance Capacity

In the application research of new energy vehicle battery technology, the battery life has always been the focus of the research [2]. The "super battery" developed by CATL improves battery life by suppressing side reactions in the charging and discharging process of lithium batteries. The key technology of the battery is to use the self-dormancy passivation film technology on the positive electrode to reduce the activity of the storage process, reduce the consumption of active lithium in the use of the cell, and achieve the effect of ultra-long life.

2.3 Charging Speed

At present, the cruising range of pure electric vehicles has basically been effectively solved, but the key problem to be solved is that pure electric vehicles cannot replace fuel vehicles in the leap-forward development of the new energy vehicle industry. The biggest pain point is the charging speed. It takes an hour or a few hours to charge the car when it is in use. According to the evaluation results of the user satisfaction index of China's new energy vehicle industry in 2019, the number of pure electric vehicle failures in 2019 was 120, an increase of 9 times year-on-year. It is worth mentioning that users have the lowest evaluation of the battery performance of pure electric vehicles, mainly due to the low performance scores of battery life and slow battery charging [3].

3 Analysis Of Social Network Model of New Energy Vehicle Battery Industry

The social network analysis method is a quantitative analysis method that obtains the interconnection between things through the analysis of the relationship and structure. The data used in this paper are not ordinary data, but belong to patent literature entries. UCINET software is the most suitable for this kind of patent data as a social network model, which can effectively learn the correlation between the patent applicant, the applicant and the application area. In this paper, UCINET software is used to analyze the cohesion density, centrality and visualization of patent applicants in the new energy vehicle battery industry. Since UCINET soft-ware has limitations on data processing, it can only upload 255×255 EXCEL matrix, so this paper only selects the top 10 patent applicants mentioned above, and conducts social network analysis on the number of applications and connections between them. Using UCINET software to analyze the relationship between the top 10 patent applicants and their countries, the number of network edges is 78; through the cohesion density analysis, the network density is 0.0322, and the standard deviation is 0.1765; through centrality analysis, the centrality index is 15.02%, and the heterogeneity is 11.48%; through cluster analysis, it is concluded that the clustering coefficient of the overall graph is 0.496, and the clustering coefficient of the weighted overall graph is 0.484. Through the visual analysis of the geographical connections among the top 10 patent applicants, it is found that the distribution of the top 10 applicants in the United States, Germany, Japan, South Korea, and China is relatively balanced, and the industry concentration is relatively low. It shows that the country's new energy vehicle battery industry is not far behind developed countries such as the United States, Germany, Japan, and South Korea. In comparison, China's BYD Co., Ltd. belongs to a single-chain structure and the speed of information dissemination is slow, making it difficult to quickly obtain innovative technologies in the new energy vehicle battery industry, resulting in relatively lagging technology, while Nissan, Toyota, Sanyo, Automobile companies such as Suzuki belong to a ring-shaped structure and the information dissemination speed is fast. The paper, UCINET software is used to analyze and detect the whole network of IPC classification number, and the number of network edges is 220. Along the path of network-cohesion-density, the whole network density of IPC classification number is 0.2366, and the standard deviation is 0.4250, along the path of network-centrality-density, the centrality index is 81.6%, and along the path of network-cohesion-clustering coefficient, the weighted overall clustering coefficient is 0.329, which shows that each IPC classification The relationship between the numbers is not close, and the core technology of the research is single. The paper extracts the IPC classification numbers of all patent data separately, selects the top 50 IPC classification numbers with the largest number of applications, and builds a 50×50 co-occurrence matrix. Through the symmetry function in the UCINET software, a symmetrical matrix is formed, and the NETWORK network is formed by using the NET-DRAW program. The specific situation is shown in Figure 1.

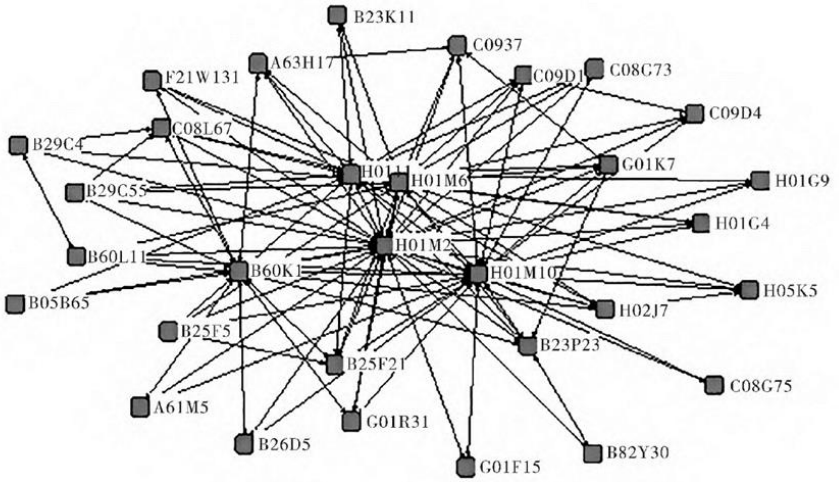

Fig. 1. Visual analysis of IPC classification numbers.

4 Innovative Models and International Comparisons of New Energy Vehicle Battery Industry

4.1 Type analysis of Chinese and foreign industrial technology innovation models

The collaborative innovation model of China's new energy vehicle battery industry is mainly based on the construction of industrial alliances. The battery industry alliance relies on leading enterprises in international, national, local, and industrial fields, and combines leading enterprises in the industrial chain and accessories enterprises in this field to jointly Cooperation in industrial innovation. Most of the foreign industrial innovation models are collaborative innovation models, and the cooperation objects of enterprises include the federal government and local governments, universities, research institutes and intermediaries. At present, the industrial alliance cooperation model under the collaborative innovation model is mainly divided into two types: equity technology cooperation model and non-equity technology cooperation model.

Table 1. Industry alliance cooperation mode.

Cooperation Mode	Name	Connotation	Features	Effect
Equity-based technology cooperation model	Joint venture	A corporate entity with independent legal personality is established jointly by two or more enterprises.	Generate new entity.	Both parties can quickly obtain new technologies and markets; shared costs and risks.

	Mergers and acquisitions	An enterprise controls or influences the acquired enterprise by purchasing all or part of the assets or property rights of another enterprise.	No new entity.	Quickly obtain the resources of the acquired party; enhance the overall competitiveness of the enterprise.
Non-equity technology cooperation model	Expert mutual visits and cooperation	Enterprises, scientific research institutions, universities or individual scientific and technological workers exchange technology, information, research results, etc.	Cooperation around technical experts.	Promotes technical exchanges among cooperative members; the level of technological innovation is high.
	Joint research and development cooperation	The two parties will jointly develop new technologies through co-construction of laboratories and establishment of projects.	Taking the laboratory as the platform and focusing on a certain project.	There is no technical reference, and the initial cost is relatively high
	Strategic cooperation	Based on a high degree of trust, both parties establish a strategic partnership, and members share long-term competitive advantages and interests to promote coordinated development.	Cooperation from a strategic perspective.	Advocating the establishment of long-term and stable cooperative relationships.

Through the comparative analysis of the above two cooperation models, we can see that the country's new energy vehicle battery industry should adopt an innovative model that combines the equity-based technology cooperation model and the non-equity-based technology cooperation model. At the international level, the country can learn from the innovation models applied by leading companies with international advantages, such as the "Creative Imitation" commonly used by Japanese companies, to form an innovation model suitable for the country's development trend; at the national level, the country's The demonstration role of national leading enterprises should be brought into full play, the strong lead the weak, and the old lead the new, so that emerging enterprises can develop rapidly and the level of innovation can be rapidly improved; at the local level, the new energy vehicle battery industry should strengthen cooperation with local universities and research institutes. Contact with the institute, use the talents and equipment resources of universities and research institutes, or purchase the patent property rights of experts and scholars, and carry out research and innovation on the basis of it, and promote the development of enterprises.

4.2 Comparison of Chinese and foreign new energy vehicle battery industry technology innovation models

China's new energy vehicle battery industry technology innovation models. According to the data released by China Association of Automobile Manufacturers, China's automobile output and sales volume have ranked first in the world for 12 consecutive years from 2009 to 2020. However, China's new energy auto start is late, and the research and development speed and quality of the core technology-battery technology are far from those of the United States, Germany, Japan, South Korea and other countries, so it is not dominant in the world. Therefore, our government should give full play to the overall consideration in the field of new energy vehicle batteries and optimize the research and development path of China's new energy vehicle battery industry. In the research and development of new energy vehicle batteries in China, the government is usually the main body, supporting the industrial development in the form of formulating encouraging policies and rationally allocating resources, so as to escort the new energy vehicle battery industry. It is an experimental platform for industrial R&D and innovation of enterprises, and the government must keep close contact with enterprises to achieve the rapid transmission and sharing of information.

The new energy vehicle battery industry technology innovation model of the United States and Germany. Because the new energy auto start in the United States and Germany is earlier and the technology is more advanced, their cooperative innovation mode is dominated by enterprises. Enterprises in the United States and Germany will not rely on the formulation and adjustment of government policies, but seek to cooperate with other organizations to promote the construction of industrial alliances-non-equity technology cooperation model. For example, in 2015, BMW in Germany was exposed to excessive emissions, and its share price continued to fall due to this influence. However, after that, BMW sought for innovation, and through full cooperation with other brands, it strengthened scientific research investment in new energy vehicle batteries, and achieved remarkable results. In addition to seeking cooperation, American companies themselves will set up overseas experimental centers, which mainly collect R&D materials and data of competitors with R&D strength, analyze and explore them, and finally report the results to the headquarters.

The new energy vehicle battery industry technology innovation model of Japan and South Korea. At present, Japan and South Korea are the most internationally competitive countries in the field of new energy vehicles. For example, Toyota has a core position in Japan's automobile industry. Besides cooperating with other companies to carry out equity-based technology cooperation model, it also actively cooperates with universities and research institutes for innovation. Whenever Japanese automobile companies notice new technologies or themes, they will take the initiative to seek solutions in scientific research institutes, trying to understand unfamiliar fields and technologies. Not only that, Toyota is not satisfied with only cooperating with local universities in Japan, but also conducting expert mutual visits and cooperation with internationally renowned universities such as Harvard University and MIT.

To sum up, except that China's new energy automobile battery industry is dominated by the government, almost all other developed countries are dominated by enterprises, but the partners of each developed country are also different. The United States tends to set up overseas research institutes, conduct voluntary integration analysis of external innovation, and conduct expert mutual visits and cooperation; Germany prefers Joint venture and Mergers and acquisitions; Japan prefers joint research and development cooperation and Strategic cooperation. Every country has its own suitable cooperative innovation mode. Countries should integrate external innovation elements, learn from each other's strong points, optimize and innovate combined resources, disperse innovation risks and promote industrial development.

5 Conclusions And Suggestions

5.1 Increase Investment in Scientific Research and Create Advantageous Fields

Based on the previous analysis of the technical theme of new energy vehicle batteries, it is known that the current research and development focus of the country's new energy vehicle batteries is in H electronics, but in addition to H01M2 and H01M10 being the focus, B60 is also in the core position, which shows that our country is in the dominant field. The investment of scientific research resources has achieved good results. Therefore, my country should continue to provide financial and tax subsidies, further consolidate its position in the field of advantageous technologies, occupy an advantageous position in the fierce competition at the international level, and build my country into a technological innovation power in the new energy vehicle battery industry.

5.2 Improve R&d Level and Participate in International Competition

At present, the country's new energy vehicle battery industry has developed rapidly. It has passed the difficult period of relying on imported new energy batteries from abroad and has entered the stage of joint development. However, the goal of the country's new energy vehicle battery industry is to achieve independent research and development, and should not stop at Joint development. the country's new energy vehicle battery industry should grasp the current growth stage, recognize its own environment, accurately assess its own strength, continuously strengthen communication and cooperation with advanced enterprises in the world and the industry, and cooperate with universities and research institutes to develop technology Tackle key problems, determine research and development goals and directions, improve the level of innovative research and development, and enhance international competitiveness.

5.3 Accelerate Collaborative Innovation and Build a Sound Mechanism

Although there are various types of industrial cooperation models in my country, it is found from the patent application data that most of the country's cooperation models

focus on cooperation between enterprises and governments, between groups and branches, and the scope of cooperation is relatively narrow and lacks breadth and depth. the country's new energy vehicle battery industry should speed up the integration of innovation resources, climb up the "R&D design" and "brand operation" along the two ends of the global value chain, seize the R&D highland, and promote the connotative high-quality development of the industry [4][5]. The "Thirteenth Five-Year Plan" pointed out that enterprises, universities and research institutes should achieve industrial collaborative innovation, break through bottlenecks, and form industrial alliances. At present, the country's new energy vehicle battery technology field is led by the government, dominated by enterprises, and supplemented by universities and scientific research institutions.

5.4 Establish A Patent Early Warning Mechanism and Enhance Intellectual Property Rights

The accumulation of protected patents is a symbol of an organization's R&D strength, and the protection of patents and other intellectual property rights is also a guarantee for the country's innovative R&D results. International status is very important. To this end, the following points should be done: First, before technology development, we should thoroughly and carefully study technology-related patent documents, pay attention to key elements such as technology fields and R&D subjects, find breakthroughs in technology development, and create our own unique advantages. Second, once you have the patented technology developed by yourself, you must continue to apply for the related patents, strive to build a protection network around the patents, consolidate your competitive position, and form a field diffusion. Third, when applying for a patent, try to avoid patent infringement, pay more attention to infringement incidents, and learn from foreign treatment methods. Once infringement occurs, measures should be taken in time to resolve international disputes and resolve crises. Fourth, we should pay attention to the maintenance of patents. my country should establish a complete patent database, update patent data information in a timely manner and disseminate relevant information about the battery industry of new energy vehicles, so that applicants can adopt corresponding adjustment strategies according to changes. Fifth, in the process of developing new energy vehicle battery technology, if it is found that the core technology has been patented by others, the patent license of this patent can be obtained by means of patent acquisition.

References

1. Zhu Jieer. Discussion on innovation of battery technology for new energy vehicles [J]. Nanfang Agricultural Machinery, 2020, 51(9):137.
2. Liu Zhengchen. Research based on new energy vehicle battery packaging strategy [J]. Internal Combustion Engines and Parts, 2020(6):251-252.
3. Xu Guoxiang, Yu Bitao, Li Fushen, Ai Juan. Analysis of Patent Application in Electrochemical Battery-New Energy Vehicle Field[J]. Power Technology,2013,37(03):495-498.

4. Liu Hongda, Sun Huaping, Zhang Qian. Analysis of China's New Energy Vehicle Industry Policy Evolution and Implementation Obstacles——Also on the Coordinated Implementation of Double Points Policy [J]. Management Modernization, 2019(4):41-46.
5. Chen Yunxiang, Sun Huaping, Zhang Qian, et al. Research on the transformation and upgrading strategy of China's new energy vehicle battery industry from the perspective of the value chain curve [J]. Economic Research Reference, 2019(9):46-51.