

# Research on Technological Innovation Network of New Energy Vehicles in China from the Perspective of Innovation Ecology

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**Abstract.** With the gradual development of energy economy, the development of new energy vehicles has become the main direction of the development of China's automotive industry. It is of great practical significance to establish a new energy vehicle technology innovation network. From the perspective of innovative ecology, this paper systematically studies the external form and internal composition of technological innovation network in China's new energy automotive industry, reveals the operation and evolution mechanism of technological innovation network in China's new energy automotive industry, and provides more feasible theoretical support for the development of technological innovation network in China's automotive industry.

## 1. Introduction

The automobile industry is an important part of the realization of “Made in China 2025”, and its level of technological innovation plays a pivotal role in the entire technological innovation system. With the continuous development and evolution of the social economy, the role of technological progress in economic growth has become increasingly prominent, market competition has gradually transformed the competition of enterprise technology innovation level. As a result, the demand for technology has gradually increased, and the development of China's automobile industry has gradually entered a stage of shifting from “mainly foreign investment” to “self-respecting research and development”. China's automobile industry gradually recognizes the main importance of technological self-innovation in the process of introducing foreign capital technology spillover effect. The technological innovation network of internal and external joint innovation has gradually become an important form of technological innovation in China's automobile industry.

## 2. Research Status of Domestic and Foreign Research on New Energy Vehicle Technology Innovation Network

The section headings are in boldface capital and lowercase letters. Second level headings are typed as part of the succeeding paragraph (like the subsection heading of this paragraph). In recent years, the technology innovation network has begun to receive great attention from scholars at home and abroad. As a newcomer in the automotive industry, new energy vehicles are far behind the traditional automobile industry in their construction of technological innovation networks, and scholars are also slightly inadequate in their research. Throughout the research status at home and abroad, the current research on the technology innovation network of the automotive industry mainly focuses on the following aspects.

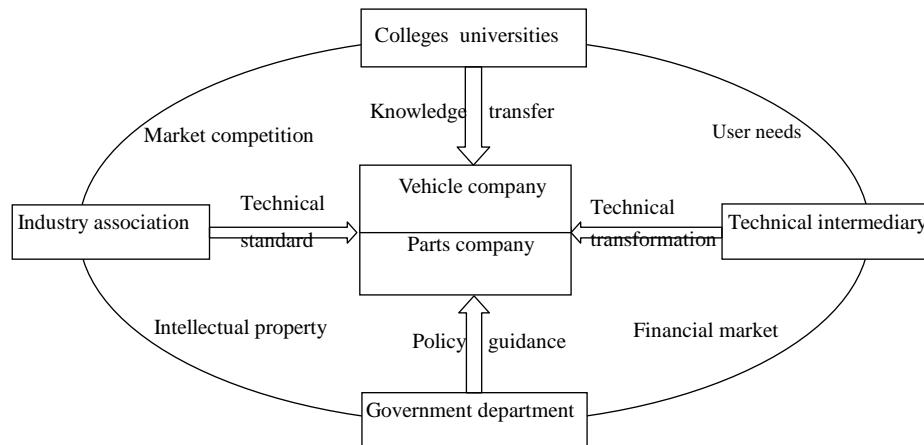
Broekel T and Boschmar analyzed the impact of social proximity on the evolution of technological innovation networks [1]. Buchamann, Pyka studied the evolution of the German automotive industry technology innovation network and found that knowledge relevance and knowledge absorption capacity are important factors affecting the development of technological innovation networks [2].

Based on the modular theory and self-organization evolution model, Dang Xinghua and others analyzed the technological innovation network to carry out continuous evolution and upgrading according to its own rules [3]. Among them, the analysis of the technology innovation network of new energy vehicles has the following research. He Yan, Guo Yanqing takes the three northeastern provinces as an example to conduct an empirical study on the new energy automobile industry research and innovation network from the perspective of social networks. The research results show that the cohesiveness of the new energy and energy industry in the three northeastern provinces is relatively poor [4]. Chen Zhu and Zuo Jingjing analyzed the innovation drive strategy of China's new energy manufacturing industry led by Geely Group under the background of "One Belt, One Road" [5]. Gu Linzhou, Shao Yunfei used social network analysis to analyze the network characteristics and information flow of China's new energy automobile industry technology innovation network [6]. However, the current research on the new energy vehicle technology innovation network mainly focuses on the evolution of the technology innovation network itself, taking the innovation ecosystem as the starting point, and studying the impact of the internal and external factors of new energy vehicles on their technological innovation capabilities. From the perspective of the new energy automobile industry, the author combines the theory of innovation ecosystem to explore the complexity and operation mechanism of the technology innovation network of the new energy automobile industry, and propose corresponding policy recommendations for optimizing the technological innovation ecosystem of the new energy automobile industry.

### **3. New Energy Automobile Industry Technology Innovation Ecosystem**

New energy vehicles refer to the use of non-traditional vehicle fuels as a source of power for automobiles, combined with technologies such as power control and driving of vehicles, to produce advanced and well-structured vehicles. New energy vehicles mainly include pure electric vehicles, hybrid vehicles, fuel cell electric vehicles, and hydrogen engine vehicles. In the process of technological innovation of new energy vehicles, China has rid of the core components of the engine of the traditional automobile industry at a disadvantage of research and development, as well as replaced it with special components such as battery packs that have industrial advantages in China. Therefore, its technological innovation ecosystem is significantly different from the traditional automobile industry.

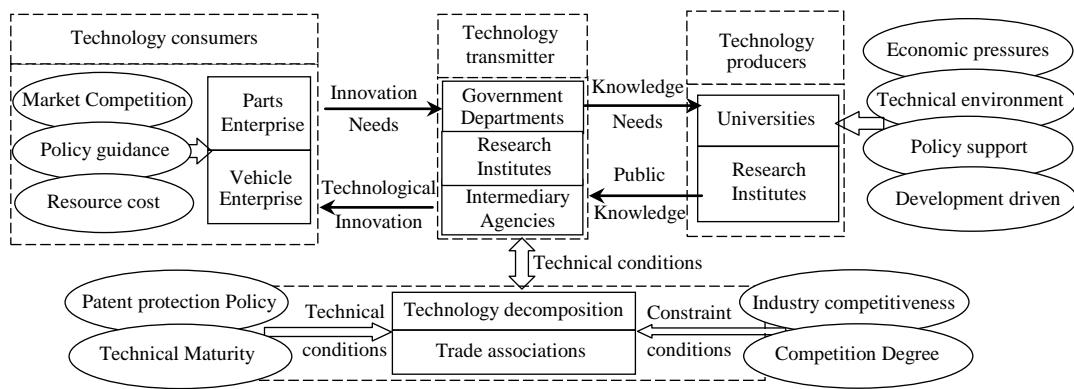
The new energy vehicle technology innovation network is centered on automobile manufacturers (including vehicle manufacturers and parts companies), and also includes universities, research institutes, competitive enterprises, consumer markets, governments, financial institutions and other departments. Among them, automobile manufacturers judge market conditions, propose technological innovation needs, and transfer demand to research institutes in a specific form. The research institute integrates the needs of technological innovation and proposes a feasible analysis report. The university provides talent and technology, and gradually completes the process of materialization of technological innovation. The whole process is transferred between different subjects in the form of knowledge flow and information flow, as indicated by Fig. 1.



**Figure 1.** Overall framework of technological innovation network in automotive industry

#### 4. The Operation Mechanism of New Energy Vehicle Technology Innovation Network from the Perspective of Innovation Ecology

In the automotive industry technology innovation ecosystem based on new energy vehicles, the various innovation entities are interconnected and constrained, and finally form a complex nonlinear innovation ecosystem, as indicated by Fig.2. Among them, new energy vehicle manufacturers, whether for their own development or market competition, need to improve the technical level and overcome the technical problems constantly in the production process. Therefore, the new energy vehicle production chain is the demander of the final innovation technology, and thus becomes the “technical innovation consumer” in the innovation ecosystem. In the new energy automobile industry, technological innovation mainly comes from the R&D department of automobile enterprises, universities and research institutes, as well as these departments constitute “technical innovation producers”. In the process of completing the demand for industrial technology innovation, new energy auto companies and universities need to use the intermediary department to complete the transmission process of innovative technologies, the main transmitters include government departments, intermediaries, and applied research institutions, forming a “technology innovation transmitter” eventually. Industry associations promote the transfer of new technologies between different companies and promote innovative technologies in the industry by setting industry standards, which enables new technologies to become the driving force for the development of the new energy automotive industry, this technology is digested and decomposed, so it is called “technical innovation digesters”. Government sector policy trends and policy documents, as well as market competition and market sector consumption trends, would guide the technological innovation of new energy vehicle companies. The financial sector affects the technological innovation activities of new energy auto companies through financing costs. Therefore, these sectors constitute the external ecological environment of the new energy vehicle technology innovation network.



**Figure 2.** Technology innovation network of automotive industry

In the entire innovation ecosystem, new energy vehicle companies have put forward technological innovation requirements in order to maintain market competitiveness. And these innovative requirements are to be decomposed, researched and innovated by their own research institutions, or commissioned by universities, research institutes and other departments. As the technology producer, universities and research institutes must analyze and innovate new technologies required by the market. Governments and research institutions provide an excellent external environment in the process of technology production, forming a technology transmitter of the automotive ecosystem. As the consumer of technological innovation, vehicle manufacturers and component companies apply innovative technologies to automobile production, and test the innovation results through the market, while consumers in the market further digest and decompose innovative technology models. In the automotive industry, the involvement of the government and the market and related intermediaries has greatly increased the coordination of the internal network of car companies. However, it is difficult to achieve a balance between coordination and benefit sharing through the company itself. Therefore, the government and intermediaries play an overall coordinated role in the ecological chain, and efficient transmitters make the ecological network more fluent and diversified.

## 5. Policies and Recommendations

With the gradual improvement of the difficulty of technological innovation, the uncertainty of the coordination and role of the various departments within the industry-university-research has greatly hindered the technological innovation of the automotive industry. Only by breaking the technical barriers between enterprises and gradually realizing the networked development of technological innovation can we promote the development of the entire new energy automobile industry. Therefore, the division of labor among its internal departments is further refined. Universities, research institutes, governments, markets, etc. constitute the core part of the technological innovation ecosystem. Each subject has their duties. Under the promotion of effective coordinated operation within the network, the technological innovation network continues to develop. In addition, we must also pay attention to the following three key issues.

First, play the role of industry associations. New energy vehicle is an emerging industry which technological innovation is mostly a breakthrough innovation, and the experience that can be learned from is scant. In the process of innovation, there are many innovation subjects involved, and only the benign coordination among the various entities can promote the development of the overall innovation ecosystem. Therefore, industry associations are needed as an intermediary to comprehensively coordinate the innovation process of productive enterprises and strengthen technical cooperation among enterprises, and complementing the advantages of technology, thereby maximizing the advantages of the technological innovation ecosystem and promoting the technological innovation level of the new energy automobile industry.

Second, we must strengthen the cooperation between new energy auto manufacturers and traditional auto manufacturers to improve the efficiency of cooperation among innovative entities.

But the development of new energy vehicles is still in its infancy. Combining the two, building the development of new energy vehicles on the development of the traditional automobile industry will maximize the use of China's existing technical conditions and talent advantages, promote the rapid development of the new energy vehicle ecosystem, reduce the technological gap with developed countries as soon as possible, and better promote the development of the national economy.

The last point, it is necessary to establish and improve the leading role of governments at all levels in promoting the development of new energy vehicles, formulate science and technology support policies that contribute to the development of new energy vehicles, and create a government-led alliance of industry, university and research cooperation, providing comprehensive policy support for the development of new energy vehicles.

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