

Research on Strategic Management Innovation Mode of Domestic Petroleum Enterprises

-- From the Perspective of Innovation Ecosystem Construction

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Abstract

To orient for national energy strategy and comply with international energy market transformation, constructing innovation ecosystem for enterprises have important strategic significance for increasing comprehensive competitiveness of domestic petroleum enterprises well as promoting the sustainable development of China's oil industry.

Keywords

Petroleum Enterprise; Innovation Ecosystem; Management.

1. Introduction

Under the background of energy transformation and orientation for constructing low-carbon energy system, China's petroleum enterprises are gradually lack of technology capacity and innovation ability in contrast to international petroleum enterprises. In order to strengthen the role of innovation driving force in promoting enterprise development and conform to the wave of digitization triggered by global informatization, constructing innovation strategic management mode shows important practical significance for domestic petroleum enterprises. The traditional management system emphasizes the role and influence of individual elements of an enterprise on the whole, while the innovation ecosystem focuses on the impact of dynamic changes of various elements of an enterprise as a whole, so as to maintain the sensitivity of the enterprise to market demand and the sustainability of its innovation ability integrally. At present, several leading enterprises at home and abroad have built innovation ecosystems based on core technologies, such as the software and hardware integration innovation ecosystem based on IOS operating system, the core product innovation ecological chain based on IOT, the computer product ecosystem based on modular architecture etc. The innovation ecosystem above plays an important role in integrating resources of enterprises.

In the era of informalization and digitalization, building innovation ecosystem can empower the overall layout and development of petroleum enterprises, strengthen internal information construction, upgrade strategic management level of enterprises, and coordinate the synergistic relationship among various elements of the ecosystem, so as to facilitate benign and sustainable development of petroleum enterprises.

2. The Dilemma Faced by Petroleum Enterprises in Constructing Innovation Ecosystem

2.1. Technological Innovation is Both Cyclical and Complex

Infrastructure is guarantee for the operation of petroleum enterprises, among which technological innovation serves as foundation for systematic construction. From the perspective of technological innovation, the innovation space of petroleum enterprises is

greatly limited, which mainly lies in the breakthrough of geological theory in petroleum exploration, technological innovation in petroleum refining as well as process innovation in transportation. For petroleum enterprises, any technological innovation in the three procedures has a significant feature of long periodicity--taking a long period from the birth of concept to industrialization. In addition, petroleum technology includes multiple links such as exploration and development, refining and chemical industry, and surface engineering. The demand for petroleum industry technology covers various fields including machinery, chemistry, biology etc., and its complexity is also reflected in the penetration of petroleum energy into various fields such as social economy and military.

2.2. "Isolated Island Phenomenon" Exists in the Innovation of Domestic Petroleum Enterprises

Any existing technology is not isolated throughout the process of creation, incubation and development, but depends on the complementarity, competition, integration or other relations between technologies for renewal and sustainable survival. However, "isolated island phenomenon" exists in domestic petroleum enterprises to a certain degree, presenting as unitary disconnection between enterprises.

In the process of breaking the "isolated island phenomenon", Chinese petroleum enterprises have had a few successful cases, among which the caprolactam production technology developed by Sinopec Research Institute of Petrochemical Technology is a typical example of the successful establishment of technological innovation ecosystem in China. Compared with the traditional production technology of caprolactam, the newly-created environmentally-friendly technology of caprolactam developed by the joint efforts of domestic research institute and petroleum enterprises effectively simplifies the production process, creating important social and economic benefits.

Innovation technology ecosystem which regards technology as center of dynamic system refers to the cooperation among upstream raw materials, midstream manufacturing and downstream market that a technology needs for its survival--instead of considering technological subject individually. Considering technological innovation from the perspective of innovation ecosystem, enterprises can more comprehensively consider the feasibility of technology promotion and evaluate its marketization ability--preventing falling into the dilemma of "having technology but no market". If domestic petroleum enterprises grow stably from "separation" to "integration" and better connect the supply side to demand side of innovative technology, the construction of innovation ecosystem will have a more solid foundation.

2.3. Barriers to Entry Remain in the World Petroleum Market

Due to uneven geographic distribution of oil resources, high density of petroleum enterprise capital and risk, the oligarch monopoly of petrochemical technology etc., the competition of the bid-scale petroleum enterprises mainly appear in forms like capital accumulation, industrial concentration and intensified monopoly phenomenon.

In order to comply with the process of market nationalization and further expand overseas petroleum business, domestic petroleum enterprises need to break through the barriers to entry remained in the world petroleum market while ensuring their own international competitiveness.

Modern petroleum industry, as a technology-intensive industrial aggregate, its development speed depends directly on update and innovative application of knowledge and technology. In recent years, international leading petroleum enterprises mostly focused on high-tech industrial structure adjustment. However, most cutting-edge theories and innovative technologies applied in domestic petroleum enterprises lack originality, and there is a gap in technological innovation ability which leads to loss of competitive advantage.

3. Suggestions on Strategic Management of Domestic Petroleum Enterprises under the Perspective of Innovative Ecosystem

As the "pillar" of human society and the "blood" of industry, the development of petroleum industry serves as the key "catalyst" to promote the growth of national economy and the process of industrialization in China. It is an important guarantee for promoting the benign development of domestic petroleum industry, maintaining China's strong international competitiveness and sustainable innovation ability.

Innovation-driven development strategy is the key to construct systematic enterprise innovation ecosystem. Enterprise presents the main body of ecosystem which connect the social factor, cultural factor, market factor of system, building collaboration between various units including technology, manpower, innovation elements such as education, information and capital through strategic management mode. Creating an innovation environment for each unit in the ecosystem fully mobilizes the initiative of innovation subjects.

3.1. Develop Education Factor -- Construct Petroleum Enterprise Personnel Training and Reserve Mechanism

As the source of technology, human resources and information of strategic management subjects--universities, teaching and research institutions and laboratories play an irreplaceable leading role in the innovation ecosystem. The introduction, training as well as reserving mechanism of talents need to be targeted and stratified to absorb talents in the energy field, ensuring the rationality of talent management system as well as enabling introduced talents to stay.

Among them, talent selection requirements and training orientation should be directed to the weak links in China's petroleum industry. The mechanism should attach importance to the comprehensive geological exploration and basic theoretical research, taking the complex geological structure in China into consideration to strengthen its exploration and development of conventional energy, improving the technical level of petroleum recovery and resource exploration. In terms of cross-border innovation and development, the concepts of cross-border talent training and technology integration of international large petroleum enterprises are also worth learning from. For example, NUCLEAR magnetic resonance imaging technology is a typical case of cross-border cooperation between the medical industry and the petroleum mining field. By analyzing the bottomhole flow situation of high-yield deep water Wells with the nuclear magnetic resonance imaging device in the hospital, accurate flow parameters in the model can be obtained, which effectively reduces the loss of pressure drop and improves the production life of oil Wells. Shell Techworks (STW) connects social entrepreneurs, technology companies and oil companies to develop complex network systems with embedded high-sensitivity gravity sensors, automated drilling components, unmanned underwater vehicles with special detection capabilities which are widely used in oil extraction to reduce the cost of oilfield development.

In addition, it is equally important to develop innovative value of talents as to ensure their well-being. The talent reserve mechanism should be supported by the scientific research service system to improve innovation efficiency and to construct efficient links between production and research. Enterprises should improve the talent evaluation system and innovation performance evaluation system, promote the innovation process of supporting policies for talents welfare and financial incentive system for innovation. Meanwhile the mechanism should escort large innovative technology research projects and intellectual property support policies, strengthening the two-way promotion relationship between enterprises and talents.

In recent years, the distinctive feature of worldwide development of petrochemical industry lies in gradual acceleration of multidisciplinary integration. In the exploration process, it

requires the combination of geophysical exploration, mathematical theories, matrix management as an auxiliary to effectively mobilize resources to improve the efficiency of petroleum enterprises' scientific research. Leading international petroleum companies emphasize the integration of upstream and downstream technologies based on multidisciplinary integration--that is to integrate interdisciplinary cooperation concepts into applications such as enhanced conventional petroleum recovery, carbon dioxide capture and storage technologies. Total Energies company effectively promote the upstream r&d institution -- French wave city research and development center set up storage center, laboratories and research centers to collect and analyze core samples from oil field from all over the world through the simulation experiments which provide data support for the innovation of drilling technology. This strategic management mode takes "collaborative innovation" as goal while "discipline integration" as cooperative link, and effectively drives the construction of innovation ecology with enterprises as the center and research institutes as the pillar.

The important role of collaborative innovation and discipline integration in technological innovation also has reference significance for domestic petroleum enterprises. For example, petroleum enterprises can set up new integrated scientific research teams to concentrate on the integrated advantages of scientific research, construction and production, creating a complete innovation incubation chain to avoid the disconnection of technology development and application. Under the concept of "integration", the meaning of technology is not limited to research and development itself, but a set of technical system combining design, construction and development. For example, Shell listed Projects&Technology, as one of the three business departments paralleled with upstream and downstream, mainly focuses on the development and integration of technology in complement for evaluation and operation phase charged by upstream and downstream departments. This "chain of integrated innovation" management mode is also implemented with Statoil ASA of Norway and Petronas of Malaysia to effectively promote the integrated strategic management of technology r&d and engineering projects.

At present, enterprises actively seek cooperation with academies of science and universities so as to establish new collaborative innovation teams centering on the same major goal, which is to promote the integration of knowledge innovation and technological innovation system construction. Petroleum enterprises rely on high-level joint scientific research forces, with abundant equipment and financial support to establish a benign effective mechanism of "industry-university-research" cooperation, accelerating theoretical application and technology incubation to drive industrial transformation. The trinity mechanism can effectively enhance the activity of education factors in the innovation ecosystem, promoting the technological breakthrough of petrochemical industry and the independently-innovate ability of domestic petroleum industry.

3.2. Respond to Social Factors -- Follow National Policies and International Trends of Innovation Cooperation

Due to the comprehensive, systematic and continuous feature of innovation ecosystem, it is necessary to have an overall view in innovating by following national policies. The strategy demand of petroleum enterprises is closely combined with the development blueprint of enterprises which is linked with the national major strategic goal of "3060 double carbon policy", so as to balance the responsibilities and tasks of enterprises through innovation.

Nowadays, China is in transition period of social and economic development. The traditional mode of exchanging environmental pollution for economic development no longer conforms to the concept of sustainable development. Promoting energy conservation and emission reduction is the inevitable mission for China on the way to build an environment-friendly society and transform the existing energy structure. The "production-pollution-treatment"

chain of traditional petroleum enterprises is no longer adapted to the trend of low-carbon and environmental protection social construction.

At present, China's oil production is in short supply, the shortage of oil resources and high pollution caused by oil exploitation are long-term problems faced by China's energy and chemical industry. In addition to seeking innovation in petrochemical technology and focusing on low-carbon development goals, it is also necessary to strengthen the development of renewable energy, utilize the characteristics of biomass energy such as cleanliness, availability and recycling to develop biomass refining and chemical industry. Now parts of the world's biomass energy technology have successfully commercialized, such as the United States energy farm, Japan sunshine alcohol, Brazil's energy plan, the development and utilization of biomass energy technology in China after decades of development has tend to mature, but the low level of overall development and utilization, still need government subsidies and other economic incentives to promote commercial development. However, the overall development prospects are optimistic. For example, biogas technology has initially achieved large-scale application and entered the initial stage of commercialization. Emerging biomass energy technologies such as biomass power generation and biomass compact briquette are in the r&d demonstration stage and are expected to gradually realize industrialization in the next 20 years. Cellulosic fuel ethanol, biomass synthetic fuel, oleophore and other technologies are also the existing research achievements of biomass resource development, which is an important direction to solve the diversification of petrochemical raw materials in China.

At the same time, petroleum enterprises need to face the trend of international innovation and cooperation. Nowadays, the world energy pattern is basically set, the impact of petrodollars around the globe leads to the dominance of the United States in the global energy market. The power of Russia, China, Northern Europe and Africa is steadily increasing while the power of Opec is gradually weakening, which is difficult for the union to continue coping with the booming trend of the global oil market. at present, China is faced with two major challenges in the international oil market: Firstly, China's depends highly on oil import and export, and its demand for raw oil is mainly dependent on imports. Therefore, the market turmoil in major oil exporting countries is closely related to the balance of China's oil market, which leads to certain impact on China's energy security. Secondly, China's transportation channels are concentrated with oil importing countries, which is not conducive to risk diversification. The Middle East, Africa and other major oil importing countries concerning petroleum trade with China all pass through the Malacca Strait, and the undiversified shipping routes lead to potential security risks and trade limitations through oil transportation. Petroleum enterprises need to consider how to improve the stability of oil resources, oil channels, oil market and oil management strategy to ensure China's energy security. Therefore, it is of great importance to strengthen the integrated development of domestic and foreign oil resources to improve the integration degree of international oil markets.

Since the implementation of "reform and opening up", China's petroleum industry has always been in the forefront of the world, both in terms of consumption volume and product quality. Petroleum enterprises need to attract innovative talents and strengthen the exchange of technological achievements around the globe, promoting the innovation cooperation mechanism between enterprises and governments. At the enterprise level, promoting domestic and foreign cooperation in research, development, production and development is of necessity, so that China's petroleum technology can better contribute to promoting the world's petroleum industry and maintaining low carbon ecological innovation environment.

3.3. Attach Importance to Enterprise Culture Factor -- Construct Value Co-create Oriented Enterprise Environment

Value is always one of the core objects of enterprise development and the direct feedback of strategic management achievements as well. With the development of productivity, value is no longer limited to consumers since producers are more involved in the process of value creation, and gradually form a community of interests with each node in the production process, realizing value co-creation through heterogeneous interaction with each enterprise spontaneously.

The co-creation act throughout innovation ecosystem emphasizes on the network collaboration, paying attention to resource sharing, win-win cooperation and joint sharing to safeguard the main body of benign operation and to maintain the stability of the whole innovation ecosystem. Purpose of which is to produce higher strategic innovation value, and to maintain ecosystem sustainable innovation ability through the output of coexistence.

When the innovation ecosystem of petroleum enterprises realizes value co-creation, it mainly faces challenges from two aspects: on the one hand, the strategic innovation will inevitably affect the existing management structure and business process of the enterprise, among which the internal transparency of the enterprise is the essential support, and the enterprise needs to establish a stable internal relationship strength. Petroleum enterprise's innovation activities mainly focus on scientific research and technology development, to avoid disclosure enterprises tend to block the information flows, but this kind of information asymmetry will generally destroy the innovation ecosystem and lower the possibility for units of enterprise of realizing value co-creation and cooperation interaction which ensures the subject information highly liquidity and transparency of innovation resources.

In view of the need to strengthen information circulation and give full play to aggregation effect and diversified cooperation, petroleum enterprises tend to locate their research institutions in parks with a certain scale. For example, CENPES brings together the R&D centers of Baker Hughes, Halliburton, Schlumberger and other oilfield service companies in the University science park of Rio de Janeiro, Brazil, to promote communication and cooperation between Petrobras and the world's top oilfield service companies. Qatar Science And Technology Park, the research and technology center established by Qatar Petroleum Corporation, has also become the oil innovation base of large international oil companies such as Chevrolet, Shell and ExxonMobil in recent years, gathering the top research and development forces of several global oil enterprises.

On the other hand, the importance of risk assessment also stands for challenge faced by enterprises. In the process of realizing value within an enterprise, all departments need to make concerted efforts instead of assuming risks independently. Jointly undertaking the technical, financial and cooperation risks that may be caused by innovation activities helps to resist the occurrence of high-risk. Enterprises need to establish a positive dialogue through the information platform to establish a better joint mechanism. Risk reduction can effectively help enterprises improve innovation efficiency and market enthusiasm, indirectly reduce the investment in risk control through the process of scientific research investment and other aspects, helping to create greater enterprise value stably.

Outside the enterprise, establishing strategic alliance is also an effective way to enhance risk resistance and overall value creation. By referring to the symbiotic mode of strategic alliance of international petroleum enterprises--such as risk sharing between Shell and Chevrolet in oil exploration and transportation business, both sides can effectively reduce risks caused by lack of capital and technical reserve. Enterprises also develop strategies such as multidisciplinary comprehensive management, integrated energy management and joint venture to complement each other's strengths in the process of innovation through shared information.

3.4. Consider Market Factors --Grasp the Opportunity of Petroleum Market Innovation and Global Energy Transformation

General Secretary of China put forward the energy security strategy of "Four Revolutions and One Cooperation" as an important instruction to enhance domestic oil exploration and development, China's oil market will therefore usher in significant strategic opportunities for development. China's major petroleum enterprises continue to optimize their structures, grasping the opportunity of the era of scientific and technological transformation and realizing the upgrading of enterprise management and business based on emerging advanced technologies and cutting-edge theories.

Nowadays, global information integration promotes the emergence of new technologies based on cutting-edge theory, and the continuous theoretical breakthroughs also promote the continuous upgrading of exploration and development technology, which is the foundation of petroleum enterprises. In the transformation of petroleum enterprises, artificial intelligence is an important strategic technology which leads the scientific and technological revolution and industrial upgrading. For the international market, Saudi Aramco uses AI technology to model and analyze data to derive oil field production, and promotes informatization as well as intellectualized of geological engineering. Exxon mobile company uses AI to improve exploration efficiency and construct intelligent offshore platforms using information technology. In contrast, domestic oil enterprises are not competitive in the international oil market due to the low level of information sharing, low investment in information platform construction and low efficiency in transformation and upgrading. In the face of the information wave, traditional domestic petroleum enterprises will face the risk of falling behind in the oil market competition if they do not timely absorb cutting-edge technologies such as artificial intelligence, transfer them from the innovation ecosystem to each unit of petroleum enterprises, and transform them into practical innovation strategies, technology applications and equipment upgrades.

In addition, the energy consumption pattern will bring a huge impact on the development of the oil industry, and the transition period from oil and gas to new energy will also bring a great opportunity for the transformation of enterprises. In terms of the domestic market, for example, sinopec and other petroleum enterprises continue to develop and utilize shale gas, biomass energy, geothermal and other emerging industries while developing traditional petroleum business. Cnooc also invests extensively in wind power, solar energy and other renewable resources. Apparently, it is not only an industry with large energy consumption and waste discharge, but also a sunrise industry with great space for technological innovation and energy conservation.

The business fields of international petroleum enterprises are mainly distributed in three fields: one is the exploration and production field, the goal of which is to expand oil resources; The second is refining oil, which aims at improving efficiency; The third is in the petrochemical sector, which goal is to effectively reduce costs. In recent years, "clean production", energy saving and consumption reduction are the market factors that must be considered thoroughly in the three fields of petroleum enterprises: "clean production" refers to the enterprise's pursuit of economic benefits while achieving the lowest degree of pollution to the environment. With the increasing requirement in demand side for gasoline quality, the traditional riser catalytic cracking technology has been unable to satisfy the requirements of the heavy oil catalytic cracking to produce clean gasoline, how to effectively improve the ability of heavy oil conversion and improve the quality of gasoline is the test faced by domestic petroleum enterprises. The key to improve efficiency of energy saving and consumption reduction is to effectively re-design and strengthen technical innovation process with the introduction of new equipment or new catalytic materials, such as the United States chevro production companies

and Powell innovated disruptively in fracturing design, which doubled production of the LostHills field in California in the early 1990s.

Compared with international petroleum enterprises, Chinese petroleum enterprises are faced with problems such as inaccurate strategic timing, insufficient action strength and lack of innovation incentives. To solve these problems, petroleum enterprises should fully consider the market factor and abandon the concept of "running every miller to draw water to one's own mill", so as to break the blocked-up system and avoid repeated homogeneity r&d project which usually causes the waste of manpower, capital and equipment resources.

Enterprises, as the main body of innovation ecosystem, shall be conducted by business interconnection strategy optimization and upgrading of the structure, following the pace of fusion energy variety trend. To broaden the business scope of enterprises, various units of which should provide interdisciplinary combinations of energy to support scientific research and trade, using innovative ideas like information exchange and value co-creation as guidance to break the business barriers between various units.

4. Conclusion

In the process of constructing innovation ecosystem of petroleum enterprises, in order to realize the Co-created values of all units and construct innovation strategy by connecting upstream and downstream, domestic petroleum enterprises need to establish personnel training and reserve mechanism to introduce innovative talents, respond to national energy policy to serve the national strategic objectives as well as domestic energy security construction. Enterprises need to comply with the international oil market trend of innovation cooperation in order to realize the strategic upgrading, creating value for oriented enterprise environment to ensure sustainable innovation, grasping trend of energy transformation based on enterprise innovation to enhance its comprehensive competitiveness.

Considering education factors, social factors, enterprise culture factors and market factors, the construction of innovative ecosystem will effectively promote the optimization of strategic management and upgrading of petroleum enterprises as well as comprehensive information construction. In addition, it may break the closure and limitation of the petroleum system, serving the innovative transformation of domestic energy structure, and hopefully enable domestic petroleum enterprises to achieve the goal of developing sustainably.

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