Qualitative and Quantitative Methods in Libraries (QQML) 8,3: 237-259, 2019

Research on Development Strategy of China's Technology Transfer Based on SWOT-QSPM Model*

Liu Yu[1,2] Fang Shu[1,2] Xu Wenjuan[1] Lu Ying[1,2] Yang Zhiping[1,2] Hou Huanhuan[1,2]

[1]Chengdu Library and Information Center, Chinese Academy of Science, Chengdu 610041

[2] Department of Library Information and Archives Management, School of Economics and Management, University of Chinese Academy of Sciences, Beijing 100190

Abstract: [**Purpose/significance**] This paper used SWOT-QSPM model to explore the most suitable development strategy for China's technology transfer. Then, it studied the priorities of the various implementation options in this strategy, and proposed countermeasures. It provided theoretical models for the future research development of China's technology transfer. [**Method/process**] This paper comprehensively investigated the four influencing factors of advantages, disadvantages, opportunities and threats of China's technology transfer development status. Furthermore, it used the SWOT model to deeply analyze the development environment, relationship and trend of China's technology transfer, and thus obtained the most suitable development strategy. Then QSPM matrix was used to determine the priority of the four alternative options for this strategy, and finally it formulated countermeasures for implementation. [**Result/conclusion**] The most suitable competitive strategy for China's technology transfer was in a good development situation in which advantages and opportunities occupied a dominant position. And the most suitable strategy for future development was the SO aggressive strategy. What's more, the four options were in order of priority, followed by policy guidance, demand orientation, integrate development and service escort.

Keywords: technology transfer, SWOT, QSPM, development strategy, alternative option

*__Corresponding author__ : Liu Yu (ORCID:0000-0001-9376-1113), librarian, Ph.D., Email: liuy@clas.ac.cn.

Other authors : Fang Shu (ORCID: 000-0003-4584-7574), professor, Ph.D. supervisor.; Xu Wenjuan (ORCID : 0000-0002-4779-4448), librarian, M.D.; Lu Ying (ORCID:0000-0003-4808-7689), associate professor, Ph.D.; Yang Zhiping (ORCID:0000-0003-3920-6797), professor; Hou Huanhuan (0000-0002-2644-8503), M.D. candidate.

Received: 1.5.2019 Accepted: 13.9.2019 ISSN 2241-1925

1. Introduction

The transformation of scientific and technological achievements is a key link between science and technology innovation and industrial application, and is one of the core driving forces for the sustainable development of social economy. Since the implementation of the innovation-driven development strategy, China has been paying more attention to the transformation of scientific and technological achievements, revised the “Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements”, and issued a series of policies and measures to promote the transformation of scientific and technological achievements, including the “Action Plan for Promoting the Transformation of Scientific and Technological Achievements”, which has set off a wave of accelerating the transformation of scientific and technological achievements.

Research and practice on transformation of scientific and technological achievements started earlier in foreign countries. In 1945, Vannevar Bush, director of the White House office of science and technology, released the report "Science: The endless frontier", which indicated that the US government began to attach importance to the integration development of scientific research and development and industrial. In the 1980s, the United States issued a series of laws and regulations such as the Bayh-Dole Act and the Federal Government Technology Transfer Law, and established a number of engineering research centers to build a long-term close cooperation mechanism between Industry-Academia-Research. Developed countries such as the United Kingdom, Germany and Japan have also introduced relevant laws and regulations on scientific and technological achievements, explored the transformation mode of achievements and created synergy organization between Industry-Academia-Research. In terms of theoretical research, Bonaccorsi et al. (1994) explored the theoretical framework of industrial and research cooperation; Etzkowitz et al. (1995) proposed triple helix innovation mode for the transformation of scientific and technological achievements, through optimizing the organizational structure and system, the sharing of Industry-Academia-Research resources and the optimization of benefits realized; Rogers et al. (2002) studied the obstacles in the transformation of scientific and technological achievements, and believed that information asymmetry and market acceptance of new technologies were the main problems; Yusuf(2008) analyzed the influence of management mechanism on the transformation mode of scientific and technological achievements from both official and unofficial perspectives; Nirmal et al. (2015) discussed the intrinsic factors affecting the transformation of scientific and technological achievements, such as compatibility and perceived differences. Domestic scholars have also carried out some effective researches on the transformation mode, influencing factors, mechanism and strategy of scientific and technological achievements. Hu Zhenya (2012), Qi Yong (2015), Zhang Shuman (2018) and others have studied the main modes, mechanisms and strategic choices of transformation of scientific and technological achievements. Zhang Huiying (2013), Huang Xiangjia (2015), Zhang Dan (2018) et al. studied

internal and external factors affecting the transformation of scientific and technological achievements. Shi Guodong (2012), Liu Yong (2014), Xu Jie (2018) and others analyzed the defects and obstacles in the transformation of scientific and technological achievements.

From the domestic and foreign research, the research on the transformation of scientific and technological achievements has become the current research hotspot, and has carried out some effective explorations in the transformation mode, influencing factors, mechanism strategies, defects and obstacles of scientific and technological achievements. However, the current research uses more qualitative analysis methods and fewer quantitative methods; In depth, there are more researches on surface phenomena, factors and mechanisms, while less consideration is given to the interaction and importance of factors.

Therefore, this study constructs a SWOT-QSPM integrated strategic research model for the transformation and development of scientific and technological achievements in China. Firstly, we systematically sort out the current situation and characteristic factors, analyze the development environment, context and trend and obtain the most appropriate development strategy of the transformation and development of scientific and technological achievements in China through the SWOT model from the four perspectives of strengths, weaknesses, opportunities and threats, Then we use QSPM matrix to analyze the priority of each implementation plan in the most suitable strategy, form specific development measures, and provide some conclusions and research models for the research on the transformation of scientific and technological achievements in our country..

2. Theoretical model

2.1. SWOT Model

The SWOT model, also called the situational analysis model, is a method that identify a variety of internal and external factors that are closely related to the target object, including the advantages S (Strengths), disadvantages W (Weaknesses), Opportunities O (Opportunities) and Threats T (Threats), organically combine the internal resources and the external environment of the target object through Survey enumeration and matrix analysis to analyze the competitive environment and make strategic decisions. SWOT model was first put forward by Professor Andrews of Harvard Business School and perfected by Professor Weihrich of San Francisco University. At present, it has been widely used in the internal and external environment of target objects for comprehensive analysis and formulation of competition strategy.

As a classical qualitative analysis tool, SWOT model can effectively point out the strategic direction, but at the same time, it also has the limitation that although it can point out the direction, it cannot determine the specific plan. Therefore, some scholars have introduced some quantitative methods to

optimize, but there are still fewer studies, especially in the field of transformation of scientific and technological achievements.

2.2. QSPM Matrix

The QSPM matrix(Quantitative Strategic Planning Matrix) which is one of the important research tools, is used to quantify the relative importance of two or more alternatives and help decision makers identify optimal solutions and strategic decisions. The principle of QSPM matrix is to simulate and score various alternatives, and reflect the priority of various alternatives through expected scores.

Therefore, this study takes QSPM matrix as an important supplement to SWOT model analysis, and organically combines the two to form a SWOT-QSPM research model, firstly, we use the SWOT model to determine the transformation and development strategy of scientific and technological achievements in China, and then we use the QSPM matrix to determine the priority of various implementation schemes in the strategy.

3. SWOT Model Research

3.1 Analysis of four characteristic factors

（1）Strengths（S）

Firstly, China has attached great importance to the transformation of scientific and technological achievements in recent years and provide a series of favorable policy environments for promoting the transformation and development of scientific and technological achievements. The 18th National Congress of the Communist Party of China proposed an innovation-driven development strategy, and regarded the transformation of scientific and technological achievements as one of the important tasks of innovation-driven development; The report of the 19th National Congress of the Communist Party of China clearly stated the requirements of “promoting the transformation of scientific and technological achievements and accelerating the construction of innovative countries”. Since the revision of the "Law of the People's Republic of China on Promoting the Transformation of Scientific and Technological Achievements" in 2015, a series of new policies, plans and measures, including the "Implementation of Several Provisions of the ‘Law on Promoting the Transformation of Scientific and Technological Achievements’" and the" Action Plan for Promoting the Transformation of Scientific and Technological Achievements ", have been successively promulgated, promoting the transformation of scientific and technological achievements to a new level. In the past two years, state leaders have pointed out on many occasions that we should "promote the integrated development of science and technology with economy", "promote the integration of production and research, and the integration of innovative entities", create a multiplier effect and put forward new ideas for the transformation of scientific and technological achievements. In December 2018, the State Council decided to replicate and promote a new batch of 23 reform measures to promote the transformation of scientific and

technological achievements to a wider scope, and the policy for the transformation of scientific and technological achievements continued to deeply develop. Secondly, the market prospects for new technologies and new products are favorable. In terms of market demand, new technologies and new products have good market and project prospects, and new technology markets and demand are continuing to grow. According to the data of the Ministry of Science and Technology, in 2017, the GDP output of 156 national high-tech industrial parks in China was 9.52 trillion yuan, accounting for 11.5% of China's total annual GDP; the operating income was 30.71 trillion yuan, up 9.03% year-on-year; the annual tax revenue was 1.2 trillion yuan, a year-on-year increase of 20.1%, accounting for 8.2% of national tax revenue. At present, the high-tech industry has become one of the fastest growing industries in China and has gradually grown into one of the pillar industries in China. Thirdly, the output of patents, papers and other scientific and technological achievements in China is large and growing rapidly. According to the data of the State Intellectual Property Office, the number of patent applications for inventions in China is 1382,000, up 14.2% year-on-year, ranking first in the world, and the number of patent authorizations for inventions is 420,000, ranking first in the world. According to the data from Institute of Scientific and Technical Information of China, in 2017, SCI database included 361,200 scientific and technical papers from China (including 323,900 Chinese first author papers), accounting for 18.6% of the total number of SCI journal papers worldwide, ranking second in the world. At the same time, the number of citations is also ranked second in the world. Fourthly, investment in science and technology continues to increase. According to the data of China Association of Science and Technology, in 2016, China continued to strengthen its investment in science and technology, with a total annual investment of 1567.67 billion yuan, an increase of 10.6% compared with 2015, and a 3.2-fold increase over 2007, with an average annual growth rate of 17.4%. From a global perspective, China's total R&D expenditure is now second only to that of the United States, which is 14.8% higher than the total expenditure of 28 EU countries such as Germany and France. Fifthly, the production capacity of enterprises and high-tech enterprises above designated size continues to grow rapidly. According to the National Bureau of Statistics, industrial added value above designated size increased by 6.6% in 2017. Thereinto, the manufacturing industry grew by 7.2%, and the power, heat, gas and water production and supply industries grew by 8.1%. The total profits of industrial enterprises above designated size reached 751.71 billion yuan, an increase of 21% over the previous year; the assets of industrial enterprises above designated size reached 112.3 trillion yuan, an increase of 6.9% over the previous year. In 2017, the added value of high-tech industry increased by 13.4% compared with the previous year. According to PwC Strategy's 2018 Global Innovation Top 1000 Research Report, 175 companies in China ranked on the list, accounting for nearly 20%; In terms of R&D expenditure, Chinese enterprises grew 34.4%, reaching 60.8 billion US dollars, the highest growth rate in the world. Sixthly, the number of science and technology intermediary

service institutions increases rapidly. The number of science and technology intermediary service organizations has been increasing, and the number of institutions such as Productivity Promotion Centers, Business Incubators, Maker Spaces, and Engineering Technology Centers has been among the highest in the world. By the end of 2015, China's technology business incubators had reached 2,530, and the total maker spaces reached 2,345, with a total of 4,875, and the number of technology incubators ranked first in the world.

（2）Weaknesses（W）

Firstly, there is a lack of high-level scientific and technological talents and teams. In recent years, although the number of scientific and technological talents in China has increased rapidly, by the end of 2016, the total number of scientific and technological employees has reached 83.27 million and the number of research and development personnel is 5.831 million, ranking first in the world. However, at the same time, high-level scientific and technological talents are still insufficient, and international top scientific and technological leaders and teams are still in short supply in our country. According to the "Global Ranking of Highly Cited Researchers" released by Clarivate Analytics, only 249 were selected to top ESI scientists by China in 2017, which is only 15.2% of that in the United States; And in about one-third of the subject categories, none of Chinese scientists has been selected. According to the ranking results of the number of foreign members in the International Academy of Authoritative Sciences by country, China ranks only 18th. According to Fortune magazine, the number of young engineers "suitable for globalization" in our country is 160,000, which is less than one third of that in the United States, and only 8% of the engineers in China are international engineers, even less than one third of India’s (25%). Secondly, the number of major breakthrough scientific and technological achievements is insufficient. Although the overall output of scientific and technological achievements in China is continuously increasing, the output of some major and breakthrough scientific and technological achievements is insufficient and progress is slow, especially the output of international leading level in the " high - tech" field is relatively small, and further strengthening of organizational guidance is urgently needed. At the same time, due to the large population base and weak foundation in our country, the per capita amount of scientific and technological achievements is still at a relatively low level in the world. Thirdly, the quality of important scientific and technological achievements such as invention patents is not high. Although the amount of patent applications and authorizations for inventions in China are very high, the quality level of these patents is uneven, and there is a lack of high-quality and high-level patents with real transformation value. Some patents are applied for factors such as project evaluation and performance appraisal, and their technical and economic values are not high. Even some scandals have emerged in some provinces in order to obtain patent application subsidies. Fourthly, the technology brokerage and technology market are not perfect. Although the transformation of scientific and technological achievements has established some science and technology intermediary and service institutions, and constantly improve the market system of technology transfer, in general, the

current various types of technology intermediary service agencies, technology brokers (technical managers) and other activities are not perfect and standardized. The marketization of technology transfer and operation activities is relatively low. For example, although some universities have set up technology transfer institutions and exist in a corporate mode, they are still administratively managed and operated, with complicated procedures and insufficient vitality, which also restrict the efficient development of the transformation of scientific and technological achievements.

（3）Opportunities（O）

Firstly, in recent years, the state has paid more attention to the transformation of scientific and technological achievements, and the national innovation-driven development strategy, the 13th Five - Year Plan for Science and Technology, and the strategy of strengthening the country through science and technology have attached importance to and promote the transformation of scientific and technological achievements. Secondly, a series of measures such as supply-side structural reform, high-quality development and innovative development of private economy have provided opportunities for rapid development of the transformation of scientific and technological achievements in our country, and have created further development space for the transformation of scientific and technological achievements in the downstream environment such as enterprises and social economy. Thirdly, in recent years, our country has continuously strengthened the construction of a strong intellectual property country, which has played a better role in promoting the transformation of scientific and technological achievements from the perspective of intellectual property. Fourth, the State Council, various ministries, provinces and cities have issued a large number of incentive policies for the transformation of scientific and technological achievements, covering aspects such as intellectual property, performance appraisal, talent introduction, etc., and continuously promote the sound and sustainable development of the transformation of scientific and technological achievements. Fifthly, the deepening development of international scientific and technological cooperation environment, such as the Grand Science Plan and the Grand Science Installation, has played a certain role in promoting the transformation of scientific and technological achievements in China.

（4）Threats（T）

Firstly, most high-tech industries belong to emerging fields. The market and demand for new technologies and new products fluctuate greatly. To a certain extent, it will affect the confidence and investment of scientific and technological achievements in the transformation of upstream and downstream units. Second, in recent years, with the continuous development of global science and technology, the development of new technologies and new products is changing with each passing day, and the competition is extremely stimulating. However, China's technological innovation advantages and leading areas are not dominant. Therefore, some situations such as overlapping technology points and low technical and economic value have emerged in the research and development of scientific and technological innovation, potentially affecting the

expected benefits of the transformation of scientific and technological achievements in China. Third, factors such as large investment and high risks in the early stage of the transformation of scientific and technological achievements, and the smooth transition of the industrial value chain of scientific and technological achievements to be optimized are also important potential threats that restrict the development of the transformation of scientific and technological achievements in our country. Fourthly, in recent years, the international environment has been changing rapidly. China and the western countries led by the United States are facing fierce competition and frequent friction in the fields of science and technology, economy and trade. As a result, national trade wars, technical barriers to trade, and technical blockades are also more frequent and complex, affecting the transformation of China's scientific and technological achievements to a certain extent.

3.2 Evaluation Matrix of Internal and External Factors

First of all, based on the information obtained from the investigation and consultation, this study sorts out the internal and external factors influencing the transformation of scientific and technological achievements in our country and formed 19 index factors with four characteristics of "strengths", "weaknesses", "opportunities" and "threats". 11 experts from the government, enterprises, research institutes, and science and technology service institutions are selected in the fields of science and technology decision-making, technology management, innovation and research, enterprise production, and technology services. We use the expert consultation method to determine the weight coefficient of each index factor, and consistency test was implemented, so as to construct an internal factor comprehensive evaluation matrix (IFE matrix, as shown in Table 1 below) and an external factor comprehensive matrix (EFE matrix, as shown in Table 2 below). Then, the evaluation of each index factor is discussed through expert consultation. Each factor is evaluated by experts according to the development of the factor, with a score of 1 - 10 and a full score of 10.

Table 1 IFE Matrix for Transformation and Development Strategy of Scientific and Technological Achievements in China

External feature	Index level	Internal factor	Weight coefficient	Score value	Weighted score
Strengths（S）	S1	The state attaches great importance to the transformation of scientific and technological	0.10	8	0.80

External feature	Index level	Internal factor	Weight coefficient	Score value	Weighted score
		achievements, which enjoys a favorable policy environment.			
	S2	The market prospects for new technologies and products are good.	0.09	8	0.72
	S3	The number of patents, papers and other scientific and technological achievements in China is numerous and growing rapidly.	0.07	7	0.49
	S4	The investment in science and technology continues to increase, ranking first in the world.	0.08	7	0.56
	S5	The production capacity of enterprises and high-tech enterprises above designated size continues to grow.	0.08	7	0.56
	S6	The number	0.07	5	0.35

External feature	Index level	Internal factor	Weight coefficient	Score value	Weighted score
		of science and technology intermediary service institutions in China has grown very well.			
	Subtotal		**0.49**		**3.48**
Weaknesses（**W**）	W1	Lack of high-level scientific and technological talents and teams	0.12	6	0.72
	W2	Insufficient quantities of major breakthroughs in science and technology	0.12	5	0.60
	W3	The quality of important scientific and technological achievements such as invention patents is not high	0.16	8	1.28
	W4	Technical brokerage and technology market are not perfect	0.11	5	0.55
	Subtotal		**0.51**		**3.15**
Total			**1.00**		**6.63**

In the internal factor IFE matrix, the weighted score of strengths (S) is 3.48 points, which is higher than the score of weaknesses (W) is 3.15 points, indicating that in the internal influence of current strategy for the transformation and development of scientific and technological achievements in

China, the Strength factors occupy a dominant position and are in a more favorable development situation.

Table 2 EFE Matrix for Transformation and Development Strategy of Scientific and Technological Achievements in China

External feature	Index level	External factor	Weight coefficient	Score value	Weighted score
Opportunities（O）	O1	National strategy, scientific and technological planning, etc., attach importance to and promote the transformation of scientific and technological achievements	0.10	6	0.60
	O2	Promotion of supply-side structural reform, high-quality development and innovative development of private economy	0.11	6	0.66
	O3	The top-level design of national intellectual property development promotes the transformation of scientific and technological achievements	0.07	7	0.49
	O4	Implementation of policy incentive mechanism for transformation	0.13	8	1.04

External feature	Index level	External factor	Weight coefficient	Score value	Weighted score
		of scientific and technological achievements			
	O5	Promotion of international scientific and technological cooperation environment, such as the Grand Science Plan and the Grand Science Installation	0.11	7	0.77
	Subtotal		**0.52**		**3.56**
Threats（T）	T1	The market and demand for new technologies and products fluctuate greatly.	0.13	6	0.78
	T2	International competition at the level of scientific and technological innovation is increasingly fierce.	0.11	6	0.66
	T3	In the early stage of the transformation of scientific and technological achievements, the investment is large and the risk is high, and the industrial value chain connecting the transformation of scientific and technological	0.15	7	1.05

External feature	Index level	External factor	Weight coefficient	Score value	Weighted score
		achievements is not smooth enough.			
	T4	Changes in the international environment, Sino - US trade wars, technical trade barriers and blockades, etc.	0.09	5	0.45
	Subtotal		**0.48**		**2.94**
Total			**1.00**		**6.50**

In the external factor EFE matrix, the weighted score of opportunity (O) is 3.56 points, which is higher than the score of threat (T) of 2.94 points, indicating that among the external factors of current strategy for transforming and developing scientific and technological achievements in China, opportunity factors occupy the dominant position and have a better ability to seize opportunities and resist threats.

Based on the results of IFE matrix and EFE matrix results, the total score of internal factors (strengths + weaknesses) and external factors (opportunities + threats) of science and technology achievements transformation and development strategy in China are 6.63 and 6.50 respectively, with an average of 6.57. The impact of internal and external factors on the overall development strategy is basically the same.

3.3 Develop development strategies and options

On the basis of the IFE matrix and EFE matrix, this study further constructs the qualitative analysis SWOT model of scientific and technological achievements transformation development strategy in China, and through the orthogonal combination of internal and external characteristics, forms four development strategies: SO strategy, WO strategy, ST strategy and WT strategy. SO strategy is an aggressive combination of strengths (S) and opportunities (O), WO strategy is a reverse combination of weaknesses (W) and opportunities (O), ST strategy is a resistance combination of strengths (S) and threats (T), WT strategy is a defensive combination of weaknesses (W) and threats (T). Each of the four strategies includes a number of strategic implementation options.

Table 3 SWOT Model of Strategies for the Transformation and Development of Scientific and Technological Achievements in China

—	**Internal Features (Horizontal)**	**Strengths (S)**	**Weaknesses (W)**
External Features (Vertical)		S1 The state attaches great importance to the transformation of scientific and technological achievements, which enjoys a favorable policy environment. S2 The market prospects for new technologies and products are good. S3 The number of patents, papers and other scientific and technological achievements in China is numerous and growing rapidly. S4 The investment in science and technology continues to increase, ranking first in the world. S5 The production	W1 Lack of high-level scientific and technological talents and teams W2 Insufficient quantities of major breakthroughs in science and technology W3 The quality of important scientific and technological achievements such as invention patents is not high W4 Technical brokerage and technology market are not perfect

		capacity of enterprises and high-tech enterprises above designated size continues to grow. S6 The number of science and technology intermediary service institutions in China has grown very well.	
Opportunities（O）	O1 The national innovation-driven development strategy, the 13th Five - Year Plan for Science and Technology, and the strategy of strengthening the country through science and technology, etc., attach importance to and promote the transformation of scientific and technological achievements O2 Measures such as supply-side reform, high-quality development and innovative development of private economy provide opportunities for	**SO strategy Aggressive combination** Seize opportunities, leverage strengths。 （1）Demand-oriented, expanding the market of new technologies and products; （2）Policy guidance, accelerate the transformation of achievements through guidance and incentive; （3）Integration and development,	**WO strategy Reverse combination** Seize opportunities,, avoid weakness （1）Accelerate the introduction of high-level talent team; （2）Lead the output of major breakthrough achievements; （3）Strengthen and improve the quality of scientific and technological achievements; （4）Promoting Standardized Operation for the marketization of technology.

	development in the downstream environment. O3 The top-level design of national intellectual property development promotes the transformation of scientific and technological achievements O4 Implementation of policy incentive mechanism for transformation of scientific and technological achievements O5 Promotion of international scientific and technological cooperation environment, such as the Grand Science Plan and the Grand Science Installation	deepening high-level cooperation in industry, academia, research and administration; （4）service escort, guide and standardize technology market and service.	
Threats（T）	T1 The market and demand for new technologies and products fluctuate greatly. T2 International competition at the level of scientific and technological innovation is increasingly fierce.	**ST strategy Resistance combination** Seize opportunities, resist threats. （1）Expand diversified development of new technologies and new products;	**WT strategy Defensive combination** Avoid weakness, resist threats. （1）Prudently carry out innovative research and development attempts; （2）Concentrate on ensuring achievements in core areas;

	T3 In the early stage of the transformation of scientific and technological achievements, the investment is large and the risk is high, and the industrial value chain connecting the transformation of scientific and technological achievements is not smooth enough. T4 Changes in the international environment, Sino - US trade wars, technical trade barriers and blockades, etc.	（2）Integrate resources to support and safeguard the strengths of scientific and technological innovation; （3）Strengthen the early support for the transformation of scientific and technological achievements; （4）Assist scientific and technological institutions to deal with international external environmental problems.	（3）Resource investment following development pattern; （4）Strengthen the Construction of Science and Technology Joint Community.

3.4 Identify development strategies

According to the scores of strengths, weaknesses, opportunities and threats in the IFE and EFE matrices mentioned above, the SWOT strategy quadrilateral of the transformation and development of scientific and technological achievements in China is drawn, as shown in Figure 1 below.

As shown in fig. 1, the focus of the SWOT strategic quadrilateral for the transformation and development of scientific and technological achievements in our country falls in the first quadrant of the coordinate axis, the area composed of strengths (S) and opportunities (O), which shows that the transformation and development of scientific and technological achievements in our country has good internal strengths and external opportunities. SO strategy combined by strengths (S) and opportunity (O) is the best development strategy at present. The SO strategy aims to seize opportunities and leverage strengths, including four options: ① Demand-oriented, expanding the market of new technologies and products; ② Policy guidance, accelerate the transformation of achievements through guidance and incentive; ③ Integration and development, deepening high-level cooperation in industry, academia, research and

administration; ④ service escort, guide and standardize technology market and service. The priority of these four options needs to be determined by QSPM matrix.

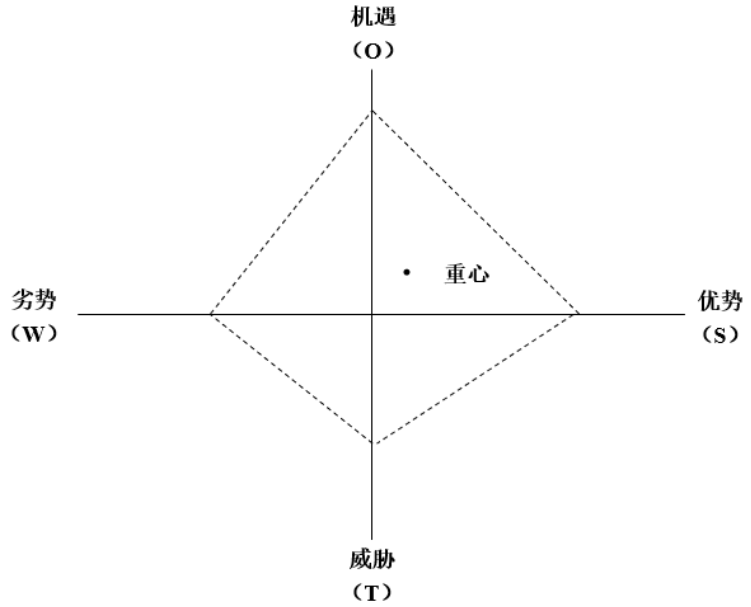

Figure 1 The SWOT strategy quadrilateral of the transformation and development of scientific and technological achievements in China

4. QSPM matrix analysis

4.1 Construction of QSPM Matrix

In this study, the four strategic implementation plans of SO strategy are horizontal indicators and the four characteristic elements of SWOT model are vertical indicators, and then we construct the QSPM matrix of scientific and technological achievements transformation competition strategy in our country (as shown in Table 4). Among them, SO_1-SO_4 refers to the four implementation plans of SO strategy. S1-S6 refers to 6 index factors of strengths (S), W1-W5 refers to 4 index factors of weaknesses (W), O1-O5 refers to 5 index factors of opportunities (O), and T1-T5 refers to 4 index factors of threats (T). ES indicates that under the simulation of the corresponding options (SO_1-SO_4), use the SWOT model to simulate and evaluate the expected implementation effect through the expert consultation method. The expected evaluation score obtained is 1-10 points, with the full score is 10 points. Among them, in the index factor scores of the two characteristics of strength and opportunity, the scores indicate the promotion effect on these positive features; In the index factor scores of the two characteristics of weakness and threat, the score indicates the improvement effect on these negative features. TES is the weighted calculation score of each index factor score ES and its weight coefficient.

4.2 Decide the priority of the options

The results in table 4 show that the scores of the four implementation plans of SO_1, SO_2, SO_3 and SO_4 are 13.01, 13.92, 11.82 and 9.92 respectively. Therefore, the priority of the four alternative strategic plans is $SO_2>SO_1>SO_3>SO_4$, indicating that the implementation plans of strategy for the transformation and development of scientific and technological achievements in China can give priority to " policy guidance", " demand guidance", " Integration and development " and " service escort".

Table 4 QSPM Matrix of Strategy for Transformation and Development of Scientific and Technological Achievements in China

Characteristic factors		Weight coefficient	Aggressive combination strategy							
			SO_1		SO_2		SO_3		SO_4	
			ES	TES	ES	TES	ES	TES	ES	TES
Strengths（S）	S1	0.10	7	0.7	9	0.9	5	0.5	6	0.6
	S2	0.09	9	0.81	7	0.63	6	0.54	4	0.36
	S3	0.07	6	0.42	7	0.49	7	0.49	4	0.28
	S4	0.08	6	0.48	8	0.64	6	0.48	4	0.32
	S5	0.08	7	0.56	6	0.48	7	0.56	5	0.4
	S6	0.07	6	0.42	7	0.49	6	0.42	9	0.63
Weaknesses（W）	W1	0.12	5	0.6	8	0.96	4	0.48	4	0.48
	W2	0.12	6	0.72	7	0.84	6	0.72	4	0.48
	W3	0.16	7	1.12	7	1.12	5	0.8	5	0.8
	W4	0.11	6	0.66	6	0.66	5	0.55	5	0.55
Opportunities（O）	O1	0.10	6	0.6	8	0.8	6	0.6	5	0.5
	O2	0.11	6	0.66	6	0.66	6	0.66	4	0.44
	O3	0.07	6	0.42	7	0.49	6	0.42	4	0.28
	O4	0.13	6	0.78	9	1.17	6	0.78	4	0.52
	O	0.11	5	0.55	7	0.77	5	0.55	5	0.5

Characteristic factors		Weight coefficient	Aggressive combination strategy							
			SO_1		SO_2		SO_3		SO_4	
			ES	TES	ES	TES	ES	TES	ES	TES
	5									5
Threats（T）	T1	0.13	7	0.91	5	0.65	6	0.78	6	0.78
	T2	0.11	7	0.77	5	0.55	6	0.66	6	0.66
	T3	0.15	8	1.2	6	0.9	8	1.2	5	0.75
	T4	0.09	7	0.63	8	0.72	7	0.63	6	0.54
Total score				**13.01**		**13.92**		**11.82**		**9.92**

5. Implementation measures

According to the analysis results of the SWOT-QSPM model mentioned above, in order to promote the better development of the transformation of scientific and technological achievements in China, this study has formed the following measures based on the four strategic implementation plans. The order is the same as the priority of the implementation plan, specifically as follows:

(1) Policy guidance. It is suggested to further optimize the management and incentive mechanism for the transformation of scientific and technological achievements. First, it is suggested to optimize the achievements transformation management mechanism, promote the integration and innovation of science and technology and economy, enhance the support function of science and technology management, and improve the policy enforcement. It is recommended that should build achievements transformation departments and functions in provinces, cities and counties, integrate functions, unify management, simplify processes, establish and improve national-provincial-city-county four-level scientific and technological achievements transformation management network, and so as to substantially promote the effectiveness of three-dimensional transformation of achievements in all regions of the country. Second, it is recommended to optimize the incentive mechanism for the transformation of scientific and technological achievements. Guide scientific research institutions to set up special offices and positions for the transformation of scientific and technological achievements, scientifically allocate resources such as job title sequence, salary, establishment and positions, and create a good professional environment for talents for the transformation of scientific and technological achievements.

(2) Demand orientation. On the one hand, it is recommended to guide the research institutions and enterprises to strengthen the layout and priority development around the current market demand and potential direction,

dredge the upstream and downstream demand systems of the science and technology innovation industry chain, and promote the continuous output and transformation of scientific and technological achievements that meet the market demand. On the other hand, it is suggested to combine innovation-driven with national strategies such as supply-side reform, high-quality development, and innovative development of private economy, find suitable focus points, stimulate market demand for new technologies, new crafts, and new products, and boost the demand for new technologies, new processes, and industrial transformation in traditional industries.

(3) Integration and development. It is recommended to promote the efficient integration and development of science and technology and economy with the innovation industry chain as the main line. From the perspective of overall transformation, we should sort out the related resources such as technologies, funds, talent teams and so on in the industry, and construct the docking mechanism and sharing platform of upstream and downstream institutions by linked, interacted and integrated, dredge and broaden the channels of transformation of scientific and technological achievements, and promote the upstream and downstream partners of the industry chain with the same strength, can quickly and efficiently match. On this basis, it is recommended to speed up the construction of an innovative industrial integration and development alliance coordinated by the government, research institutions, enterprises and service organizations to ensure efficient integration of resources, good docking of demand, and promote the deepening development of scientific and technological achievements.

(4) Service escort. It is suggested to speed up the establishment and improvement of a standardized service system for the transformation of scientific and technological achievements, and further standardize and guide the commercial operation of the science and technology intermediary service market. Under the current environment of rapid development of science and technology intermediary services in China, we will explore to construct a " internet +" standardized service system of achievements transformation, and guide and improve the market-oriented operation system for the transformation of scientific and technological achievements. It is suggested to speed up the introduction of management system and service standards for the transformation of scientific and technological achievements, standardize the commercial operation behavior of scientific and technological intermediary service institutions, and guide the continuous development of scientific and technological achievements transformation services in a standardized, high-level and comprehensive direction.

6. Conclusion and enlightenment

This paper systematically combs the development of the transformation of scientific and technological achievements in our country. Starting from the four

characteristic factors of strengths, weaknesses, opportunities and threats, it analyzes the development environment, context and trend of the transformation of scientific and technological achievements in our country by using SWOT model, and comprehensively concludes that the transformation of scientific and technological achievements in our country is in a good development situation in which strengths and opportunities predominate and the SO aggressive strategy is the most suitable development strategy in the future. Then, using QSPM matrix to analyze the priority of the four implementation plans of the strategy, which are "policy guidance", "demand orientation", "integration and development" and "service escort" in turn. Based on this, form detailed implementation measures to promote the better development of the transformation of scientific and technological achievements in our country.

There are still some deficiencies in this paper, mainly lies in the analysis of the transformation of scientific and technological achievements in China as a single object, and the insufficient consideration of the impact of the competitive development of multiple objects, so it has certain limitations. We will further improve the future research to make it as scientific, reasonable and accurate as possible.

References

[1] Bush, V. (1945). Science: the endless frontier. *Nature*, 48(3), 231-264.

[2] Fuentes, D. D. (1999). On the limits of the post-industrial society structural change and service sector employment in spain. *International Review of Applied Economics*, 13(1), 111-123.

[3] Chen, L.; Feng, C. J.; Chen, R.; Jiang, D. (2016). Experience Reference of UK's Promoting Sci-tech Achievements Transfer and Transformation---Take National Technology Innovation Centre and Industry-University-Research Innovation System as Example. *Science & Technology Progress and Policy*, 33(15), 9-14.

[4] Wen, Z. B.; Hu, M. (2016). The German Experience and Enlightenment of University Science and Technology Innovation Leading Industry Development. *Research in Educational Development*, (9), 58-64.

[5] Li, X. H.; He, D. F.; Peng, J. (2018). The Transformation Model of Scientific and Technological Achievements in Japanese Universities. *Science & Technology Review*, 2018, 36(2): 8-12.

[6] Bonaccorsi, A.; Piccaluga, A. (2010). A theoretical framework for the evaluation of university-industry relationships. *R & D Management*, 24(3), 229-247.

[7] Dr. Etzkowitz, H.; Leydesdorff, L. A. (2014). The triple helix of university-industry-government relations: a laboratory for knowledge based economic development. *Social Science Electronic Publishing*, 14(1), 14-19.

[8] Rogers, E. M. (2002). The nature of technology transfer. *Science Communication*, 23(3), 323-341.

[9] Yusuf, S. (2008). Intermediating knowledge exchange between universities and businesses. *Research Policy*, 37(8), 1167-1174.

[10] Kundu, N.; Bhar, C.; Pandurangan, V. (2015). Managing technology transfer: an analysis of intrinsic factors. *South Asian Journal of Management*, 22(3): 69-95.

[11] Hu, Z. Y. (2012). Research on the Main Body, Transformation Model and Incentive Mechanism of the Transformation of Scientific and Technological Achievements. *Seeker*, (12), 173-175.

[12] Qi, Y.; Zhu, T. T.; Guo, Y. (2015). Research on the Transformation Model and Efficiency Evaluation of Scientific and Technological Achievement Market. *China Soft Science*, (6), 184-192.
[13] Zhang, S. M.; Yuan, C. H.; Li, Y.; Lei, P. (2018). Collaborative science and technology entrepreneurship and technology's effective commercialization :A case study on Xi'an Institute of Optics and Precision Mechanics. *Studies in Science of Science*, 36(4): 644-653.
[14] Zhang, H. Y.; Shi, Z. W. (2013). Fuzzy Cognitive Research of the Influencing Factors During Scientific and Technological Achievements Transformation Based on Innovation Diffusion Perspective. *Science of Science and Management of S.&.T.*, 34(5): 28-35.
[15] Huang, X. J. (2015). Influencing Factors and Realization Path of the Transformation of Scientific and Technological Achievements in Universities. *Chinese University Science & Technology*, (3), 95-96.
[16] Zhang, D.; Liu, H. Y.; Yuan, J. (2018). Research and Prospects of Factors Affecting the Transformation of Scientific and Technological Achievements. *Chinese University Science & Technology*, (3): 75-78.
[17] Shi, G. D. (2012). Internal Barriers and Countermeasures of the Transformation of Scientific and Technological Achievements in Universities. *Education and Vocation*, (14), 172-174.
[18] Liu, Y.; Huang, J. S. (2014). The Barriers to Technology Transfer from University to Industry,
R & D Management, 26(3): 129-134.
[19] Xu, J. (2018). Institutional Barriers and Elimination of the Transformation of Scientific and Technological Achievements——In Accordance with the Construction of an Innovative Country. *Modern Law Science*, (2): 119-131.
[20] Panagiotou, G.; Wijnen, R. V. (2005). The "telescopic observations" framework: an attainable strategic tool. *Marketing Intelligence and Planning*, 23(2), 155-171.
[21] Agarwal, R.; Grassl, W.; Pahl, J. (2012). Meta-swot: introducing a new strategic planning tool. *Journal of Business Strategy*, 33(2), 12-21.
[22] Xiang, G. P.; Yang, Z. (2013). Innovation of Enterprise Strategic Decision Analysis Tools: Joint Application of SWOT and QSPM. *Enterprise Economy*, 400(12), 23-27.
[23] Liu, Y.; Yang, Z. P.; Wang, C. M.; Du, Q.; Ge, Q. (2016). Industrial Competitiveness Evaluation Methods Based on an Optimized Diamond Model——A Case Study of Machinery Industry in China. *Modern Information*, 36(4), 62-69.
[24] Chen, J. D.; Deng, M. (2017). Research on the Development Strategy of Major Science and Technology Achievements Transformation Database in Guangdong Province Based on SWOT and PEST Analysis. *Science and Technology Management Research*, 23: 166-173.
[25] Li, G.; Yang, M. (2017). Study on Transformation Development Strategy of Datong Coal Mine Group Based on SWOT-QSPM Model. *Coal Technology*, 36(10), 303-304.
[26] David, F. R. (1985). Computer-assisted strategic planning in small businesses. *Journal of Systems Management*, 7: 24-34.
[27] Liang, W.; Li, Y. J.; Wang, J.; Zhu, H. Z.; Liu, C. X.; Gong, H. (2017). Method for evaluating the life of line-connected fittings based on improved QSPM matrix. *Insulators and Surge Arresters*, (3), 187-192.