

RESEARCH ON STRATEGIES FOR THE HIGH-QUALITY TRANSFORMATION OF SCIENTIFIC AND TECHNOLOGICAL ACHIEVEMENTS IN UNIVERSITIES AND RESEARCH INSTITUTES IN DALIAN

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Abstract: The transformation of scientific and technological achievements plays a crucial role in driving economic development through innovation, as well as in promoting the advancement of regional economy and industrial upgrades. Exploring the high-quality transformation of scientific and technological achievements in universities and research institutes in Dalian can significantly contribute to the cultivation and development of new productive forces, thus driving economic growth in the region. However, the current state of transformation of scientific and technological achievements in Dalian's universities and research institutes is characterized by a low local transformation rate, subpar transformation quality, and insufficient service level. This paper proposes four suggestions to enhance the transformation of scientific and technological achievements in Dalian: improving the source supply mechanism, strengthening collaboration between universities, research institutes, and enterprises, establishing a high-level scientific and technological intermediary service system, and enhancing the level of technological maturity in achieving successful transformation of scientific and technological achievements.

Keywords: Dalian; Universities and Research Institutes; Transformation of scientific and technological achievements

1 INTRODUCTION

Universities and research institutes play a vital role in driving technological revolutions and industrial transformations, serving as key contributors to fundamental research and major technological breakthroughs. Leveraging the leading position of universities and research institutes in scientific and technological innovation and promoting organized scientific research are essential for enhancing social innovation capability and fostering high-quality economic and social development. Dalian is home to universities and scientific research institutes that possess abundant resources and exceptional research capabilities. Enhancing the efficiency and quality of the transformation of scientific and technological achievements in these institutions will greatly contribute to the economic development of Dalian. Through an analysis of statistical data pertaining to the transformation of scientific and technological achievements in Dalian's universities and research institutes, this paper aims to explore the existing challenges and provides targeted suggestions to promote the high-quality transformation of scientific and technological achievements in Dalian.

2 ANALYSIS OF THE CURRENT STATUS OF THE TRANSFORMATION OF SCIENTIFIC AND TECHNOLOGICAL ACHIEVEMENTS IN DALIAN'S UNIVERSITIES AND RESEARCH INSTITUTES

2.1 Transformation of Technological Achievements in Universities and Research Institutes

The transformation of technological achievements in universities and research institutes exhibits an active and stable trend. In 2023, there was a significant increase in both the quantity and transaction amount of scientific and technological achievements transformed by universities and research institutes in Dalian, compared to 2022. Among the top three universities in Dalian in terms of technology export contract transaction amount for 2023 were the Dalian Institute of Chemical Physics of the Chinese Academy of Sciences, Dalian University of Technology, and Dalian Maritime University. Notably, the Dalian Institute of Chemical Physics of the Chinese Academy of Sciences ranked first with a transaction amount of 1.409 billion yuan (Table 1).

Table 1 Top 10 in Technology Turnover of Universities and Research Institutes in 2023

Name of universities and research institutes	2022		2023	
	Number of contracts (items)	Transaction amount (ten thousand yuan)	Number of contracts (items)	Transaction amount (ten thousand yuan)
Dalian Institute of Chemical Physics	198	22280.36	313	140949.01
Dalian University of Technology	371	40581.34	736	59864.82
Dalian Maritime University	49	2417.03	583	22759.37

Dalian Polytechnic University	161	5196.55	193	7486.22
Liaoning Ocean and Fisheries Science Research Institute	78	3345.87	92	4151.14
Dalian University	19	1508	48	2932
Dalian Jiaotong University	56	1801.76	69	2291.92
Dalian Ocean University	18	571.45	69	1680.69
Dalian Minzu University	17	349.51	52	1413.7
Dalian Neusoft Institute of Information	62	471.13	77	1227.18
Dalian Medical University	2	111	36	1182.8

Data source: Dalian National Technology Contract Management and Service System

2.2 Industrial Distribution of the Transformation of Scientific and Technological Achievements in Universities and Research Institutes

This section analyzes the composition of technical fields for technology contracts in Dalian's key technology transactions. Over the past three years, the majority of technology contracts have been concentrated in the advanced manufacturing sector, accounting for approximately 30% of the total transaction volume in Dalian and ranking first. This trend aligns with Dalian's economic development plan, which emphasizes the growth of the manufacturing industry. Furthermore, the development of strategic emerging industries, including electronic information, new energy and energy efficiency, and new materials and applications, also exhibits a consistent trajectory. The city's rapid growth in urban construction, social development, and modern transportation has provided substantial support for the expansion of Dalian's modern service industry. Notably, respective values have increased from 4.05 billion yuan and 140 million yuan in 2021 to 10.22 billion yuan and 8.27 billion yuan in 2023 (Table 2)

Table 2 Technology Composition of Dalian Technology Contract from 2021 to 2023

technical field	Contract number			turn volume			Transaction volume in 2023	
	2021	2022	2023	2021	2022	2023	proportion	increase
Advanced manufacturing	609	426	547	138.9	128.1	160.9	31.82%	25.63%
Urban construction and social development	245	228	378	40.5	104.6	102.2	20.22%	-2.25%
Modern traffic	219	149	761	1.4	45.5	82.7	16.35%	81.78%
electronic information	6244	4,685	5,661	57	62.5	70.7	13.97%	13.05%
New energy and high energy efficiency	256	285	422	56.8	30	54.2	10.72%	80.68%
New materials and their applications	208	202	359	3.4	8.5	10.2	2.02%	20.10%
aerospace	138	87	108	6.8	4.9	9.6	1.90%	95.88%
Environmental protection and comprehensive utilization of resources	354	489	553	15	40	9.4	1.87%	-76.38%
Biological, pharmaceutical, and medical devices	200	168	251	1.6	2.9	5.4	1.07%	86.59%
agriculture	34	32	103	0.2	0.1	0.3	0.07%	232.47%
Nuclear application	0	3	3	0	0.02	0.1	0.01%	206.70%
Total	8507	6754	9,146	336.2	427.3	505.8	100%	18.4%

Data source: Dalian National Technology Contract Management and Service System

2.3 Localization Rate of the Transformation of Scientific and Technological Achievements in Universities and Research Institutes

In terms of analyzing the number of projects for transforming scientific and technological achievements, the overall localization rate of universities and research institutes in Dalian increased from 41.6% in 2022 to 44.3% in 2023. The institutions with the top five highest localization rates in 2023 were Liaoning Normal University (73.1%), Neusoft Institute of Information (70.5%), Dalian Polytechnic University (68.9%), Dalian Medical University (67.2%), and Dalian Jiaotong University (60.9%).

Regarding the analysis of transaction amounts in the transformation of scientific and technological achievements, the overall localization rate of universities and research institutes in Dalian increased from 18.2% in 2022 to 35.7% in 2023. The institutions with the top five highest localization rates in 2023 were Neusoft Institute of Information (70.5%),

Liaoning Provincial Institute of Oceanography and Fisheries (63.6%), Dalian Minzu University (56.5%), Dalian Ocean University (54%), and Dalian Jiaotong University (51.7%)(table 3).

Table 3 Local Transformation of Scientific and Technological Achievements of Universities and Research Institutes in Dalian from 2022 to 2023

University research institutes	Number of scientific and technological achievements transformation projects in 2022 (one)			Transaction amount of transformation of scientific and technological achievements in 2022 (RMB 10,000)			Number of scientific and technological achievements transformation projects in 2023 (one)			Transaction amount of transformation of scientific and technological achievements in 2023 (RMB 10,000)		
	Total	Dalian	Conversion rate in Dalian	Total	Dalian	Conversion rate in Dalian	Total	Dalian	Conversion rate in Dalian	Total	Dalian	Conversion rate in Dalian
Dalian Institute of Chemical Physics	299	101	33.8%	64272.1	6918.8	10.8%	348	131	37.6%	101753.0	42059.2	41.3%
Dalian University of Technology	78	28	35.9%	3345.9	885.7	26.5%	92	36	39.1%	4151.1	2640.2	63.6%
Dalian Maritime University	541	184	34.0%	50204.8	6663.2	13.3%	829	332	40.0%	74051.2	21552.0	29.1%
Dalian Polytechnic University	333	103	30.9%	13233.3	3882.3	29.3%	509	137	26.9%	21185.8	2721.9	12.8%
Liaoning Ocean and Fisheries Science Research Institute	66	31	47.0%	1206.7	530.7	44.0%	121	59	48.8%	2917.5	1648.6	56.5%
Dalian University	29	13	44.8%	407.4	176.0	43.2%	61	41	67.2%	955.9	306.3	32.0%
Dalian Jiaotong University	112	59	52.7%	3473.4	852.1	24.5%	92	56	60.9%	2122.7	1098.4	51.7%
Dalian Ocean University	42	24	57.1%	1296.4	506.6	39.1%	52	38	73.1%	495.4	159.6	32.2%
Dalian Minzu University	185	124	67.0%	6375.1	3612.9	56.7%	273	188	68.9%	8521.5	4155.6	48.8%
Dalian Neusoft Institute of Information	139	58	41.7%	2858.6	689.5	24.1%	191	95	49.7%	2728.2	1473.5	54.0%
Dalian Medical University	52	34	65.4%	2712.9	2188.0	80.7%	95	50	52.6%	1974.8	932.9	47.2%

Dalian Institute of Chemical Physics	76	54	71.1%	497.8	413.9	83.1%	61	43	70.5%	402.6	296.4	73.6%
Total	1952	813	41.6%	149884.4	27319.7	18.2%	2724	1206	44.3%	221259.8	79044.7	35.7%

Data source: Dalian Municipal Science and Technology Bureau

3 ISSUES IN THE TRANSFORMATION OF SCIENTIFIC AND TECHNOLOGICAL ACHIEVEMENTS IN DALIAN

3.1 Low Conversion Rate of Scientific and Technological Achievements in Dalian

In Dalian, the conversion rate of scientific and technological achievements in universities and research institutes is relatively low. In 2023, the proportion of local transactions of scientific and technological achievements from Dalian's universities and research institutes significantly increased to 35.7% (compared to 18.2% in 2022). However, the majority of transactions involved the transfer of technological achievements outside the region, accounting for as much as 64.3% (Table 4). Notably, Dalian Maritime University had the lowest proportion of local transactions, with only 12.8%, followed by Dalian Medical University at 32%.

Table 4 The Situation of the Transformation of Scientific and Technological Achievements in Dalian's Major Universities and Research Institutes in 2023

University research institutes	The number of achievement transformation projects is in the continuous proportion	Achievement transformation project transaction volume in the continuous proportion	University research institutes	The number of achievement transformation projects is in the continuous proportion	Achievement transformation project transaction volume in the continuous proportion
Dalian Institute of Chemical Physics	37.6%	41.3%	Dalian Jiaotong University	60.9%	51.7%
Liaoning Ocean and Fisheries Science Research Institute	39.1%	63.6%	Liaoning normal University	73.1%	32.2%
Dalian University of Technology	40.0%	29.1%	Dalian Polytechnic University	68.9%	48.8%
Dalian Maritime University	26.9%	12.8%	Dalian Ocean University	49.7%	54.0%
Dalian Minzu University	48.8%	56.5%	Dalian University	52.6%	47.2%
Dalian Medical University	67.2%	32.0%	Dalian Neusoft Institute of Information	70.5%	73.6%
Total				44.3%	35.7%

Source: Dalian Science and Technology Bureau

3.2 Low Transaction Quality of Scientific and Technological Achievements in Dalian

In terms of profitability in the transformation of scientific and technological achievements, the overall profitability of universities and research institutes in Dalian is relatively low, with a low average contract amount for technology transfer. Table 5 shows that the nationwide average amount for each technology transfer contract in 2023 was 40.15 thousand RMB. However, several universities in Dalian, excluding Dalian University of Technology, Liaoning Oceanographic Academy, Institute of Chemistry of Chinese Academy of Sciences, and Dalian Maritime University, fell below this average. This indicates that Dalian's universities and research institutes face challenges in optimizing the value and quality of scientific and technological achievements.

Moreover, the technological content of scientific and technological achievements available for technology transfer in Dalian is relatively lower compared to achievements from other regions. The average contract amount for the

transformation of scientific and technological achievements in major universities and research institutes in Dalian is 81.2 thousand RMB, significantly higher than the average amount for local technology transactions at 65.5 thousand RMB.

Table 5 Situation of Contract Amounts for the Transformation of Scientific and Technological Achievements in Major Universities and Research Institutes in Dalian

University/Research Institute	Number of Transformation Projects	Number of Projects Transformed Locally	Total Transaction Amount (thousand RMB)	Transaction Amount Locally (thousand RMB)	Average Contract Amount (thousand RMB)	Average Contract Amount in Dalian (thousand RMB)
Dalian Institute of Chemical Physics	348	131	101753.0	42059.2	292.4	321.1
Liaoning Ocean and Fisheries Science Research Institute	92	36	4151.1	2640.2	45.1	73.3
Dalian University of Technology	829	332	74051.2	21552.0	89.3	64.9
Dalian Maritime University	509	137	21185.8	2721.9	41.6	19.9
Dalian Nationality University	121	59	2917.5	1648.6	24.1	27.9
Dalian Medical University	61	41	955.9	306.3	15.7	7.5
Dalian Jiaotong University	92	56	2122.7	1098.4	23.1	19.6
Liaoning Normal University	52	38	495.4	159.6	9.5	4.2
Dalian University of Technology	273	188	8521.5	4155.6	31.2	22.1
Dalian Ocean University	191	95	2728.2	1473.5	14.3	15.5
Dalian University	95	50	1974.8	932.9	20.8	18.7
Dalian Neusoft Institute of Information	61	43	402.6	296.4	6.6	6.9
Total	2724	1206	221259.8	79044.7	81.2	65.5

Source: Dalian Science and Technology Bureau

3.3 Insufficient Collaboration between Universities, Research Institutes, and Enterprises

Insufficient collaboration between major universities, research institutes, and enterprises in Dalian is evident. As depicted in Table 6, the average number of jointly established research and development institutions with enterprises per university and research institute nationwide was 3.6 in 2022. Similarly, the average number of newly established or invested enterprises was 0.9. While a few universities surpassed these averages, the majority fell short. Surprisingly, nearly half of the universities and research institutes did not engage in collaborations to establish research and development institutions or invest in new enterprises. Hence, the existing connections and collaborative efforts between Dalian's universities, research institutes, and enterprises appear insufficient and lack depth.

Table 6 Collaboration between Universities, Research Institutes, and Enterprises

Universities and research institutes	The number of r & d institutions jointly built with enterprises	Create and share in the number of new enterprises	Universities and research institutes	The number of r & d institutions jointly built with enterprises	Create and share in the number of new enterprises
Dalian Institute of Chemical Physics	6	0	Dalian Jiaotong University	7	0
Liaoning Ocean and Fisheries Science Research Institute	0	0	Liaoning normal University	0	0

Dalian University of Technology	3	3	Dalian Polytechnic University	4	0
Dalian Maritime University	5	6	Dalian Ocean University	0	0
Dalian Minzu University	0	0	Dalian University	3	2
Dalian Medical University	0	0	Dalian Neusoft Institute of Information	0	0
National average of universities and research institutes				3.6	0.9

Source: Dalian Science and Technology Bureau

3.4 Lack of Concept Validation Centers and Low Project Maturity

Research projects at universities and research institutes in Dalian often revolve around theoretical innovations, prioritizing advancement and originality in research and development rather than market demand. Consequently, research results may lack transformation value, as projects may deviate from market needs[1]. Additionally, the promotion of concept validation centers in Dalian is insufficient. While cities like Beijing, Shanghai, Shenzhen, Hangzhou, and Guangzhou have established concept validation centers to facilitate joint validation activities among universities, research institutes, enterprises, and other innovative entities, Dalian has only established concept validation centers in Jinpu New Area and Dalian University of Technology, in collaboration with enterprises and incubation bases. These centers require further development, as their functions and roles are not entirely clear in society.

4 RECOMMENDATIONS FOR ENHANCING THE TRANSFORMATION RATE OF SCIENTIFIC AND TECHNOLOGICAL ACHIEVEMENTS IN DALIAN

4.1 Improve the Source Supply Mechanism and Strengthen Cooperation between Universities, Research Institutes, and Enterprises

First, refine the project approval mechanism to align with market demand. Optimize the process of forming scientific and technological projects to ensure continuous participation of enterprises in various stages such as project selection, guideline formulation, and R&D execution. Second, enhance the integration between industry, academia, and research in enterprises to enhance the quality of scientific and technological achievements. Promote a collaborative innovation model involving industry, academia, research, where market issues are addressed, enterprise needs are identified, university solutions are provided, and government support is offered. Third, support the establishment of joint R&D institutions by enterprises, universities, and research institutes. Utilize enterprises' understanding of industry trends and market demand to prioritize project approvals, making research outcomes more applicable to practical production. Fourth, establish a "use before transfer" model for scientific and technological achievements along with a risk compensation mechanism for failed technology transfer[2].

4.2 Develop a High-level Technology Intermediary Service System

First, encourage universities and research institutes to establish specialized technology intermediary organizations. This allows for the enhanced market development, promotion, and industrialization of technology outcomes. Combining the introduction of excellent technology service agencies from other regions with the cultivation of local technology service institutions can improve the professionalism of technology intermediaries. They will provide specialized services such as intellectual property rights, legal advice, asset assessment, and technological evaluation for technology transfer and outcome conversion. Second, promote the high-quality development of local technology intermediary organizations. Capitalize on provincial technology intermediary institutions by leveraging their demonstrative and radiating role to facilitate the transfer and conversion of regional scientific and technological achievements. Strengthen the construction of exemplary technology intermediary institutions in Dalian, coordinating technical selection, transaction matching, and intellectual property services for technology transfer. Exploration of a registration management system for technology intermediary institutions is recommended.[3] Third, cultivate and develop a team of technology managers. Utilize existing talent training bases for technology intermediaries to foster a strong team of technology transfer professionals in Dalian. Provide business training for these technical managers and support them in legal advice, financing, asset assessment, technological evaluation, intellectual property, and contract registration. Enhance the professional service capabilities of technology transfer professionals while encouraging their involvement in the entire technological achievement conversion process. Fourth, establish guidance management mechanisms for technology management firms along with certification and training mechanisms for technology managers. Clearly define promotion channels and

foster versatile technology intermediary talents who possess in-depth knowledge of technology, market, finance, and management.

4.3 Strengthen Technological Achievement Transformation and Improve Technological Maturity

First, enhance the promotion of concept validation centers to bridge the gap between basic research outcomes and commercialization. Establishing concept validation centers aids the effective integration of the "four chains" (talent, industry, innovation, and fund chains) to increase the rate and quality of technology transformation. Second, enhance the construction of scientific and technological achievement transformation platforms in universities and research institutes. Encourage these institutions to establish pilot platforms for technology transformation, utilizing new models of market operation and adopting a "test-first, incubate-later" approach[4]. By integrating existing resources and focusing on core services such as sample and prototype development and clinical verification, aim to further enhance technological achievement maturity, efficiency of technology transformation, and the number and value of transformation contracts for technological achievements.

4.4 Incentivize Local Transformation of Technological Achievements

To address the issue of low local transformation in universities and research institutes, comprehensive incentive measures can be implemented. First, assess and incentivize universities and research institutes in Dalian to ensure substantial progress in local transformation. Second, provide financial incentives to technology achievement owners to stimulate enthusiasm and innovation, thereby encouraging priority transformation into practical applications. Third, enhance incentives for local businesses engaged in technological achievement transformation, promoting active participation to achieve widespread local application of technological achievements. Fourth, improve financial support measures by providing funding and financial services to reduce risks and costs associated with local technological achievement transformation, further fostering transformation and application of technological achievements.

COMPETING INTERESTS

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