

## Analysis Of Scientific Innovation In Thailand

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**Keywords:** Thailand; Scientific Innovation; S&T Innovation Policy

**Abstract:** Based on the report of the Ministry of Science and Technology of Thailand as well as thematic reports published by relevant international organizations, scientific innovation in Thailand has been analyzed in terms of scientific input, output and impact based on the InCites database. Besides, prioritized industries have been concluded based on S&T innovation policy in Thailand. The study has found that Thailand is in the upper middle of the world in terms of S&T input and output, but as to impact, Thailand is in the lower middle of the world. The key research disciplines, advantageous disciplines, and prioritized industries have similarities and differences. When expanding science and technology cooperation between China and Thailand, we should pay more attention to the different priorities of the above three aspects so as to adopt a differentiated approach. China and Thailand should increase cooperation in such disciplines as infectious diseases and immunology to achieve common development; China should strengthen cooperation with Thailand in disciplines like pharmacology & pharmacy to enhance its scientific influence in Thailand. We should seize the opportunity of industrial adjustment in Thailand to promote cooperation in engineering, electrical & electronics and food science & technology so as to enhance China's cooperation status in Thailand.

### 1. Introduction

Thailand is currently at a crossroads in its national development. Driven by foreign investment, Thailand has achieved remarkable economic and social progress over the past three decades, which contributes to its official access to the rank of middle-income countries in 2011. However, recent years have witnessed that Thailand has slowed down its economic development significantly. According to statistics, Thailand's economy grew at an average annual rate of 9.1 percent prior to the Asian financial crisis, and the GDP in the decade prior to 2010 grew at an average annual growth rate of 4.6 per cent, with an average GDP growth rate of 5.8 per cent, 3.0 per cent and 3.4 per cent respectively during the Ninth to Eleventh Five-Year Development Plan[1]. In 2019, Thailand's annual GDP growth rate was only 2.4%[2]. Meanwhile, Thailand's national scientific innovation is in the doldrums, ranking only 43rd as reported in the Global Innovation Index 2019[3]. Thus, Thailand has introduced a series of S&T innovation policies in an attempt to transform and upgrade its industries through S&T innovation, which has also provided the opportunity for China to deepen scientific cooperation with Thailand under "the Belt and Road Initiative". Therefore, in terms of scientific input, output and impact, this paper makes an analysis of Thailand's scientific innovation, key research disciplines and advantageous disciplines based on the InCites database by reviewing the reports of the Ministry of Science and Technology of Thailand and the thematic reports issued by relevant international organizations. In addition, the latest S&T innovation policy is combined to inform and assist China in opening up new spaces for science and technology cooperation with Thailand.

### 2. S&T Inputs: S&T Funding and S&T Personnel

S&T investment in Thailand is described in terms of Research and Development Intensity (GERD as percentage of GDP) and Researchers (Per million inhabitants, FET).

**Table 1.** Science and technology investment in thailand, 2013-2017

Years	Science and Technology investment	
	GERD as percentage of GDP	Researchers, Per million inhabitants
2013	0.44%	791
2014	0.48%	964
2015	0.62%	865
2016	0.78%	1208
2017	1.00%	1350

Sources: United Nations Educational, Scientific and Cultural Organization Institute for Statistics, dataset obtained from Science, Technology & Innovation: Research and Development.

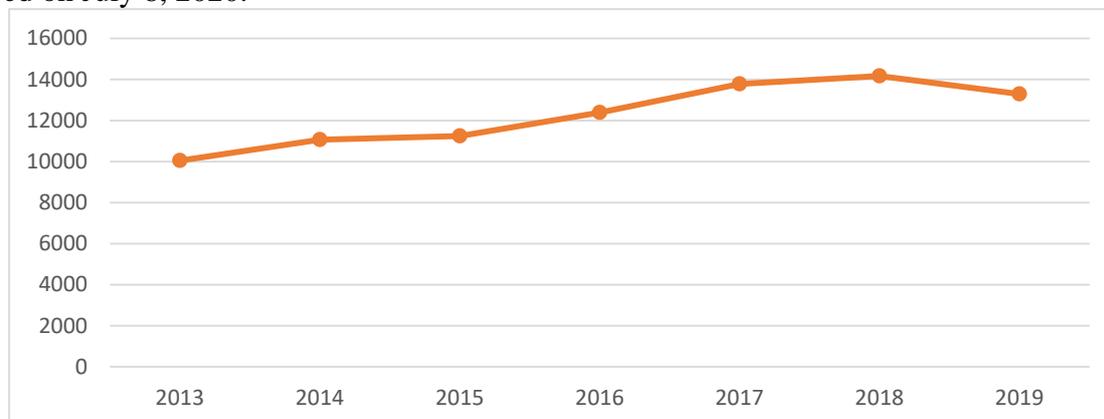
Research and Development Intensity (Gross domestic expenditure on R&D (GERD) as percentage of GDP), can reflect technological innovation of a country or a region and an important STI measure of technological transformation investment. As shown in Table 1 (the latest annual data available for Thailand), Thailand's research funding intensity in the total 5 years from 2013 to 2017 shows an increasing trend, from 0.44% in 2013 to 1.00% in 2017, but it is still below the global average of 1.72% (2017)[4]. The European Commission considers that a mature economy should have a value of 2% and above for the intensity of S&T funding, which shows the under-emphasis and chronic sluggishness in S&T funding in Thailand[5].

Researchers (Per million inhabitants, FET) serves as an important measure of the human capital investment in STI R&D in a country or region. As seen in Table 1, the number of researchers in Thailand has shown an increasing trend year by year, from 791 in 2013 to 1,350 in 2017, slightly higher than the global average of 1,198 (2017)[4], reflecting Thailand's emphasis on nurturing scientific and technological talent.

From a global perspective, the Global Innovation Index 2019 report shows that Thailand ranked 46th in research funding intensity (out of 129 countries), 48th in the number of researchers per million inhabitants, and in the upper middle of the world in the overall investment in STI.

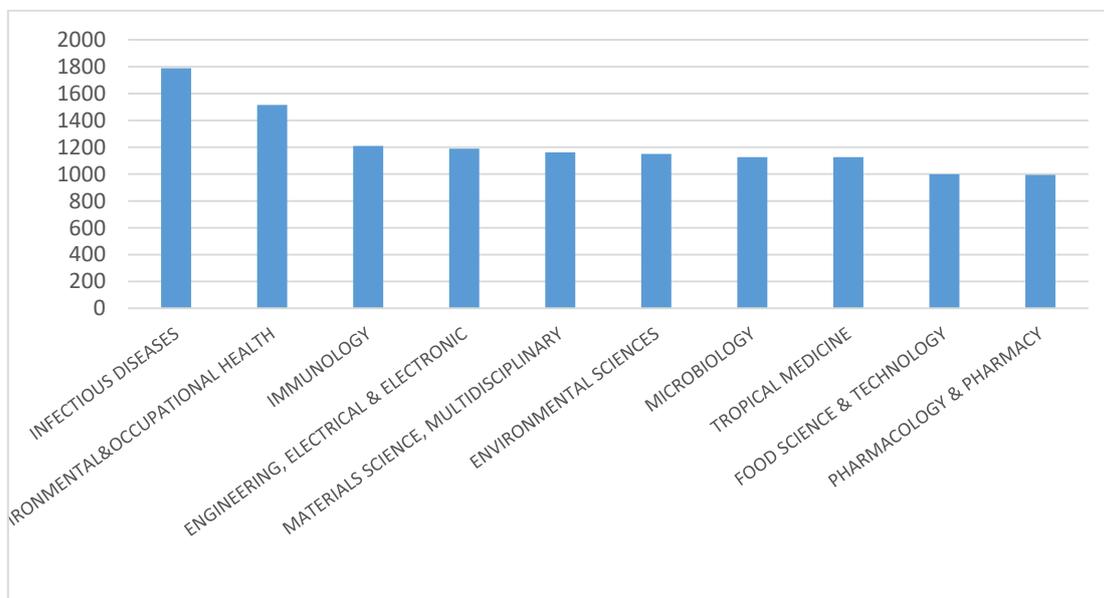
### 3. Scientific Output: the Number of Academic Papers and Key Research Disciplines

Scientific papers, as milestones of research activities, serve as fundamental indicators for assessing the performance of STI activities[6]. Therefore, scientific papers are selected as an indicator to analyze the scientific innovation in Thailand in the research. The selected database is InCites database which covers data from WOS database more than 30 years based on global benchmark data. A survey of 3,000 researchers from more than 170 countries and regions in terms of research output and impact was conducted for multiple comparison and analysis, which is retrieved on July 8, 2020.



**Figure 1.** Distribution of the number of scientific papers in Thailand, 2013-2019 (piece)

In terms of the number of scientific and technical papers in Thailand during 2013 and 2019 (Figure 1), the number of Thai papers totaled 85,993, and it is an overall fluctuating upward trend with 10,045 in 2013 increasing to 14,173 in 2018, as well as a slight decrease by 2019 to 13,295 papers. One of the reasons is that international science and technology partnerships have contributed to the increase in the number of international collaborative scientific papers in Thailand, rising from 4,266 in 2013 to 6,923 in 2018, with international collaborative scientific papers accounting for the total papers also increasing from 42.47% in 2013 to 52.07% in 2017.



**Figure 2.** Number of key research papers in Thailand, 2013-2019 (Piece)

The results of the WOS database searches in Thailand during 2015 and 2019 are collated to summarize the top ten disciplines with the most cited papers by WOS classification, namely, the advantageous disciplines in Thailand in the past 5 years (Figure 2). Firstly, as shown in Figure 2, infectious diseases, public, environmental & occupational health, immunology, tropical medicine and pharmacology & pharmacy rank the top three, eight, and ten of Thailand's key research disciplines with 1,789, 1,515, 12,120, 1,126 and 994 papers respectively, showing that Thailand is highly active in the field of medical disciplines. Secondly, Thai researchers are highly active in the field of engineering, electrical & electronics, materials science, multidisciplinary and food science & technology, which reflects the importance of the electronics and food processing industries in the current Thai economy. Finally, Thai researchers focus on the environmental sciences and microbiology, reflecting the Thai government's emphasis on the environment and the biotechnology.

#### 4. S&T Impact: Quality of Academic Papers and Dominant Disciplines

The citation status of scientific papers serves as an important index to evaluate the quality of scientific papers and the international influence of scientific research, which is generally reflected by the total times cited, citation impact and category normalized citation impact (CNKI). CNKI refers to the standardization of the cited frequency of scientific papers in disciplines, publication time and literature types. When  $CNKI=1$ , the quality of the scientific papers is equal to the global average level; when  $CNKI>1$ , the quality of the scientific papers is higher than the global average level; when  $CNKI<1$ , the quality of the scientific papers is lower than the global average level.

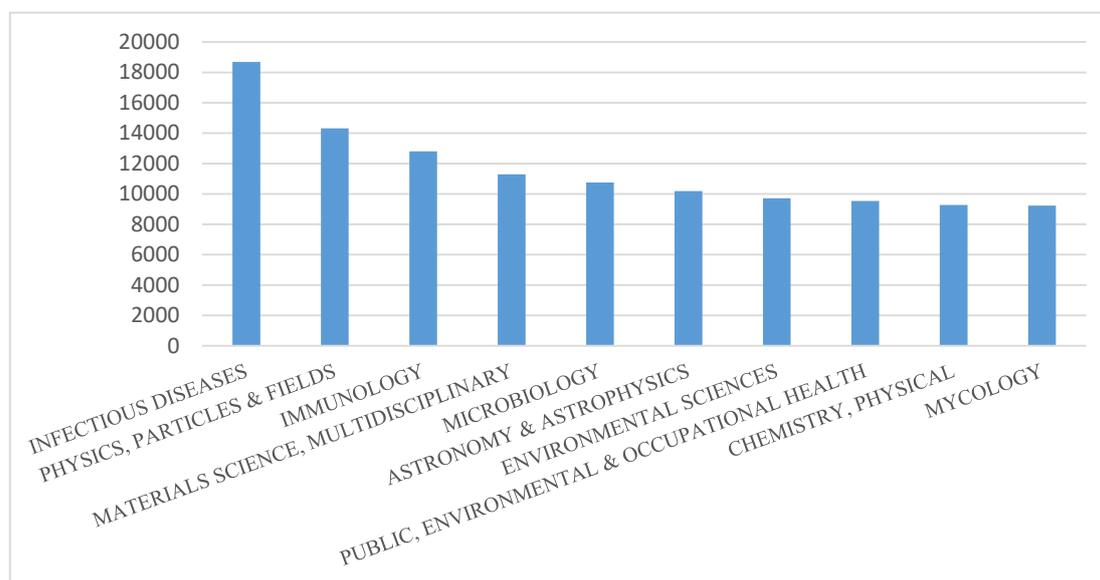
**Table 2.** Citations of scientific papers in Thailand, 2013-2019

Year	Times Cited		Citation Impact		Category Normalized Citation Impact	
	Times Cited/Time	World Ranking/Name	Times Cited/Time	World Ranking/Name	Impact	World Ranking/Name
2013	128753	45	12.82	119	0.99	112
2014	119605	47	10.81	147	0.93	136
2015	110306	47	9.81	148	1.00	142
2016	100267	47	8.09	152	0.92	169
2017	72491	48	5.26	173	0.86	173
2018	48653	47	3.43	160	0.93	156
2019	18968	47	1.43	130	0.95	159

As shown in Table 2, there is an overall decreasing trend in total times cited and citation impact in Thailand during 2013-2019, down from 128,753 in 2013 with 12.82 times to 18,968 in 2019 with 1.43 times. Besides, the total citation frequency has small inter-annual variation and top world ranking, however, its citation influence has lower world ranking.

In terms of the category normalized citation impact, Thailand only has a value of 1 in 2015, the rest all less than 1, indicating that the overall quality of Thailand papers is lower than the world average. Considering the total number of Thailand papers mentioned above, the number of papers included is increasing year by year, however, the category normalized citation impact and citation impact rank low, indicating an imbalance between the quantity and quality of Thailand's paper publications. Compared to its overall increasing trend in the number of papers, the quality of papers needs to be improved.

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**Figure 3.** Citations of superior subjects in Thailand, 2015-2019 (Times Cited)

The results of the WOS database searches in Thailand during 2015 and 2019 are collated to summarize the top ten disciplines with the most frequently cited papers by WOS classification, namely, the advantageous disciplines in Thailand in the past 5 years (Figure 3). First and foremost, from Figure 3, it can be seen that, Thailand holds a strong position in medically related fields such as infectious diseases, immunology, public, environmental & occupational health, with infectious diseases ranking first with 18,686 total citations. Secondly, Thai researchers are active in physics, particles & fields, astronomy & astrophysics, chemistry and physics, material science and

multidisciplinary, reflecting the current importance of Thailand's manufacturing economy and the Government's aspiration to establish a regional energy hub as an Asian trading platform for petroleum and petrochemical products. Thirdly, environmental science ranks 7th with 9,718 total citations, reflecting Thailand's commitment to environmental protection and sustainable development. Finally, Thai researchers in microbiology and mycology enjoy high scientific impact, which reflects the current strengths of Thailand in biotechnology.

## **5. S&T Innovation Policy: Prioritizing Industry Development**

Currently, Thailand's traditional export-oriented industrialization is confronted with multiple restrictions like the loss of the demographic dividend, insufficient scientific and technological development, and an irrational industrial structure. In order to remain competitive and overcome the "middle-income trap", Thailand needs to promote economic development based on innovation, creativity and knowledge. It becomes an innovation-driven economy through a shift from a manufacturing economy to a service-based one. In this regard, the Government of Thailand is committed to promoting the development of science, technology and innovation as the key to becoming an innovation-driven economy. Therefore, in 2016, the Government of Thailand, in line with the principles of "full economic development" and "the 2030 Agenda for Sustainable Development", launched The Twelfth National Economic and Social Development Plan (2017-2021) as well as "Thailand 4.0 Strategy" for economic and social development in the next two decades. In 2018, the government also put forward 20-year National Strategy (2018-2037) to advance Thailand towards "Thailand 4.0".

According to the Government of Thailand, "Thailand 4.0" is designed to enable Thailand to surpass the previous "middle-income trap", "inequality trap" and "imbalance trap" brought by agriculture-focused "Thailand 1.0", light-industry-emphasized "Thailand 2.0" and complex industry-emphasized "Thailand 3.0" respectively. It is an economic model characterized by an innovation-driven and high value-added economy[7]. Under the "Thailand 4.0" economic development strategy, the government has designated ten industrial clusters: five for existing industries with new technologies, and five for future industries with new investment opportunities. The former five industries include modern automobile manufacturing, intelligent electronics, high-end tourism and health tourism, agriculture and biotechnology, as well as food processing. The latter five industries consist of robotics manufacturing, aviation, biofuels and biochemistry, digital economy as well as comprehensive medical industry[8].

## **6. Analysis Of Thailand's Scientific Innovation**

Since the Asian financial crisis, Thailand has shifted its focus from an export-led growth strategy to an innovation-driven growth strategy, with an increased emphasis on science, technology and innovation as the country fell into a "middle-income trap".

### **6.1. Thailand is in the Upper Middle of the World in Terms Of S&T Input and Output, and in the Lower Level in Terms Of S&T Impact From a Global Perspective.**

From S&T development across the world, Thailand's research funding intensity is well below the world average in terms of S&T investment, with researchers per million inhabitants slightly above the world average; in terms of S&T output, Thailand has shown an overall increasing trend in the output of papers, the number of papers rising from 10,045 in 2013 to 13,295 in 2019. The percentage accounting for the total number of papers in the world has also increased from 0.32% in 2013 to 0.34% in 2019; in terms of S&T impact, Thailand ranks high in the total citation frequency of scientific papers, but the per capita citation frequency and CNKI index rankings are relatively low in the world, indicating a serious imbalance between the quantity and quality of S&T papers. Generally speaking, Thailand's overall level of S&T innovation ranks among the upper middle of the world in terms of S&T input and output, but in terms of S&T impact, the quality of its scientific

papers is far below world standards and needs to be further improved.

## **6.2. It has Similarities and Differences in Terms of Key Research Disciplines, Advantageous Disciplines and Prioritized Industries**

A comparison of the distribution of key research disciplines and advantageous disciplines in Thailand reveals that some of the key research disciplines and advantageous disciplines overlap with each other, which shows that these disciplines have a good foundation and prospect. Those key research disciplines without entering the ranks of dominant disciplines indicate that the quality of discipline development needs to be further improved; those that are only If the discipline has advantages but has not entered the key research disciplines, those advantageous disciplines failing to be key research disciplines need to expand the scale of discipline. Those disciplines such as infectious diseases, immunology and environmental science have good foundations and prospects. It is worth noting that of infectious diseases rank first in both categories, showing the high importance. These disciplines like engineering, electrical & electronics, tropical medicine, food science & technology and pharmacology & pharmacy have only entered into key research disciplines, indicating the shortage of innovation as well as development strengths. Disciplines of physics, particles & fields, astronomy & astrophysics, chemistry and physics, and mycology enter into advantageous disciplines, which indicates that the scale of these disciplines needs to be expanded. Combined with Thailand's STI policy, it can be found that Thailand's current and future prioritized industrial development directions and its current key research areas and strengths are compatible. For instance, food science & technology is a key research discipline and a prioritized industry but not a advantageous discipline, indicating that Thailand has yet to develop further in these disciplines.

## **Conclusion**

In order to further expand the cooperation between China and Thailand in science and technology, based on the analysis of the current scientific innovation, the current status of discipline development and its analysis of prioritized industries, this paper makes the following recommendations: China and Thailand should pay more attention to their different emphasis on key research disciplines, advantageous disciplines and priorities of industries, thus adopting a differentiated approach to carry out scientific research cooperation. China and Thailand should increase cooperation in disciplines like infectious diseases and immunology so as to achieve common development. China should strengthen cooperation with Thailand in the field of pharmacology & pharmacy and other disciplines in order to enhance China's influence on science and technology in Thailand and to seize the opportunity of industrial adjustment in Thailand to promote the development of Chinese science and technology in Thailand. The Chinese government is also working to enhance the status of China's scientific and technological cooperation in Thailand through scientific and technological cooperation in disciplines such as engineering, electrical & electronics and food science & technology.

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