



Final Report

Co-Creating Strategy for UK-Thailand Cooperation in Science, Research and Innovation (SRI)

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TABLE OF CONTENTS

EXECUTIVE SUMMARY	3
CHAPTER 1 INTRODUCTION	4
1.1 Background	4
1.2 Rationale	5
1.3 Conceptual Framework and Objectives	5
CHAPTER 2 LITERATURE REVIEW	7
2.1 The Status of UK Science, Research and Innovation (SRI)	7
2.2 Review of SRI in Thailand	15
2.3 UK-Thailand SRI Collaboration	21
CHAPTER 3 METHODOLOGY	26
CHAPTER 4 RESULTS AND FINDINGS	29
4.1 Online survey	29
4.2 In-depth interviews	30
4.3 Focus group and case study	31
CHAPTER 5 STRATEGIES AND POLICY RECOMMENDATIONS	41
APPENDIX I LIST OF LITERATURE REVIEWED	46
APPENDIX II SCIVAL ANALYSIS	47
APPENDIX III LIST OF INTERVIEWEES	50
APPENDIX IV ONLINE SURVEY	52
APPENDIX V CO-CREATION WORKSHOP	55
APPENDIX VI PUBLIC DIALOGUE	56
APPENDIX VII TEAM	58
REFERENCES	60

EXECUTIVE SUMMARY

The Co-Creating Strategy for UK-Thailand Cooperation in Science, Research, and Innovation (SRI) project provides the evidence base needed to derive a strategy for the next phase of UK-Thailand cooperation in SRI. The project identifies common challenges and opportunities for sustainable development between the UK and Thailand. This report was used to help frame UK-Thailand scientific partnership after the Newton Fund and Global Challenges Research Fund (GCRF) is coming to a closure, hence the need to capture lessons and feedback to help inform future directions.

In order to develop and map the areas of scientific collaboration between the two countries, the project collected multiple layers of information, including:

- Literature review of emerging policy priorities and challenges in both countries,
- SciVal analysis of UK-Thailand joint publications and identification of specific areas of common interest where collaboration with the UK is a priority,
- An analysis of lessons learned from implementation of the Newton Fund and the GCRF in Thailand was conducted through both an on-line survey, using questionnaires, and
- A series of in-depth interviews and focus group discussions with key stakeholders, including Newton Fund and GCRF grantees, funding agencies, policy makers and government agencies.

Representatives from each of the stakeholder groups participated in four focus group discussions, which allowed for information exchange and in-depth discussion on lessons learned as well as opportunities and challenges for future UK-Thailand SRI partnerships to be identified.

The findings were refined through discussions with project advisors from both Thailand and the UK, followed by an on-site co-creation workshop to ensure that the findings and recommendations are clear, rigorous, and accurate, and can be packaged in a way that is accessible and relevant to those who take decisions.

Consequently, the final report was drafted from the results of the co-creation workshop. The report provides three main strategy recommendations, including suggested research topics for next phase of collaboration, models for funding mechanisms, guidelines for management, as well as other recommendations.

The suggested topics for UK-Thailand collaboration from this project are: 1) climate change; 2) infectious diseases & NCDs; 3) agriculture & food security; 4) AI; 5) genomics; 6) circular economy; and 7) synthetic biology. Two models are proposed for funding mechanisms, consisting of a matching fund model and a block grant model. * Other recommendations concern intellectual property management, evaluation and project progress reporting systems, and participation of young researchers, etc.

The outcomes of this project were disseminated through a hybrid public dialogue meeting comprising more than 50 key stakeholders from the UK and Thailand.

*Please note that the report provides a list of recommendations for wider collaboration and may not necessarily reflect the mechanism of the International Science Partnerships Fund that was launched during the Project delivery.

CHAPTER 1 INTRODUCTION

1.1 Background

Science, research and innovation have become powerful determinants of social and economic development. Economic globalisation combined with rapid increases in population has seen the emergence of issues that do not respect national boundaries, such as food security and climate change. In 2022, the Food and Agriculture Organization estimates that between 691 million and 783 million people faced hunger globally. Half of the world population also suffered from water scarcity due to climate crisis.

No one nation can mobilise the resources, technical or financial, to confront and deal with these problems alone. The trans-national nature of these issues requires multi-partner, cross-sectoral, and trans-boundary approaches to science, research and innovation. The solutions to these problems require sharing scientific knowledge and expertise between researchers across different partners of the world.

UK-Thailand scientific partnerships

The UK and Thailand have enjoyed a long and productive history of collaboration in science, research and innovation. Many of Thailand's preeminent scientists began their academic and research careers at British universities and today academics and researchers in Thailand are actively involved in joint research activities with leading UK universities, research institutes, and the private sector.

One important step in giving UK-Thailand SRI collaboration a strategic focus was the "UK-Thailand Partners in Science" initiative, which was launched in 2009 by NSTDA, National Science Technology and Innovation Policy Office (STI) and Thailand Research Fund (TRF). This initiative comprised UK-Thailand scientific workshops, researcher mobility grants.

In 2015 the UK and Thailand launched the "Newton UK - Thailand Research and Innovation Partnership Fund" to support world class joint research and innovation. The UK and Thailand committed up to £20 million over five years for science, research and innovation collaboration. The funding was then further extended to 7-year partnership due to its success. This partnership supported science programs in areas directly relevant to tackling Thailand's development challenges and promoting socio-economic wellbeing, including co-funded research on climate-resilient rice, flooding and climate hazards, cancers, and infectious diseases, as well as building capacity for researchers at different stages of their career.

The GCRF was a part of FCDO's Official Development Assistance (ODA) to developing countries. The fund was allocated by the UK's Department for Business, Energy and Industrial Strategy (BEIS), and focused on tackling key challenges affecting developing countries such as secure and resilient food systems supported by sustainable marine resources and agriculture, sustainable health and well-being, inclusive and equitable quality education, clean air, water and sanitation and affordable, reliable, sustainable energy.¹ In the UK, 10 projects² supported by BBSRC, EPSRC, ESRC, MRC and RCUK Collective Fund collaborated with Thailand and most of them were under the two challenging areas of sustainable health and well-being, and secure and resilient food systems.

UK-Thailand SRI cooperation covers a range of activities in different sectors, including agriculture and food security, climate resilience, health and infectious diseases, and advanced manufacturing. In the next phase of the UK-Thailand partnership, it is essential that this diverse set of activities should

¹ GCRF at <https://www.newton-gcrf.org/gcrf/>

² According to the database RCUK GCRF Awarded Projects by Research Councils UK
<https://public.tableau.com/app/profile/research.councils.uk/viz/RCUKGCRFFundedProjects/RCUKGCRFAwardedProjects>

collectively contribute to sustained positive socio- economic outcomes in the UK and Thailand, and that funding to support these partnerships is of mutual benefit.

1.2 Rationale

As scientific knowledge becomes inextricably linked in modern societies with social progress and economic growth, the public authorities, the private sector, and civil society must all invest in knowledge generation and in promoting its widespread use as a capital asset to develop and remain competitive.

To address global challenges such as COVID-19, impacts from climate change and sustainability issues, many of which have significantly impacted Thailand and the UK, there is a need to further develop a vibrant UK-Thailand science, research and innovation ecosystem that can support research cooperation, knowledge sharing, capacity building, job creation, and economic growth for mutual benefit. To ensure productive cooperation in the future, it is important to take stock of existing UK-Thailand partnerships, to identify success stories and analyse lessons learned, and then develop a strategy that can further enhance scientific capacity and competitiveness in both countries, resulting in global impacts.

This project will provide the evidence base needed for the next stage of a mutually beneficial partnership to tackle common challenges and opportunities for sustainable development between the UK and Thailand.

1.3 Conceptual Framework and Objectives

The objectives of this study are as follows:

1. To review the current status of science, research and innovation in Thailand and to address the challenges and opportunities for the sustainable partnership between UK and Thailand,
2. To analyse the Thailand-UK collaboration programmes with a focus on the Newton Fund and GCRF, and to derive lessons learned from the implementation of these programmes, and
3. To utilise these evidence-based findings to develop a framework and create strategy recommendations for UK-Thailand Cooperation in Science, Research and Innovation (SRI) that will deliver mutual benefit for both countries.

The conceptual framework of this study is shown in Figure 1.1

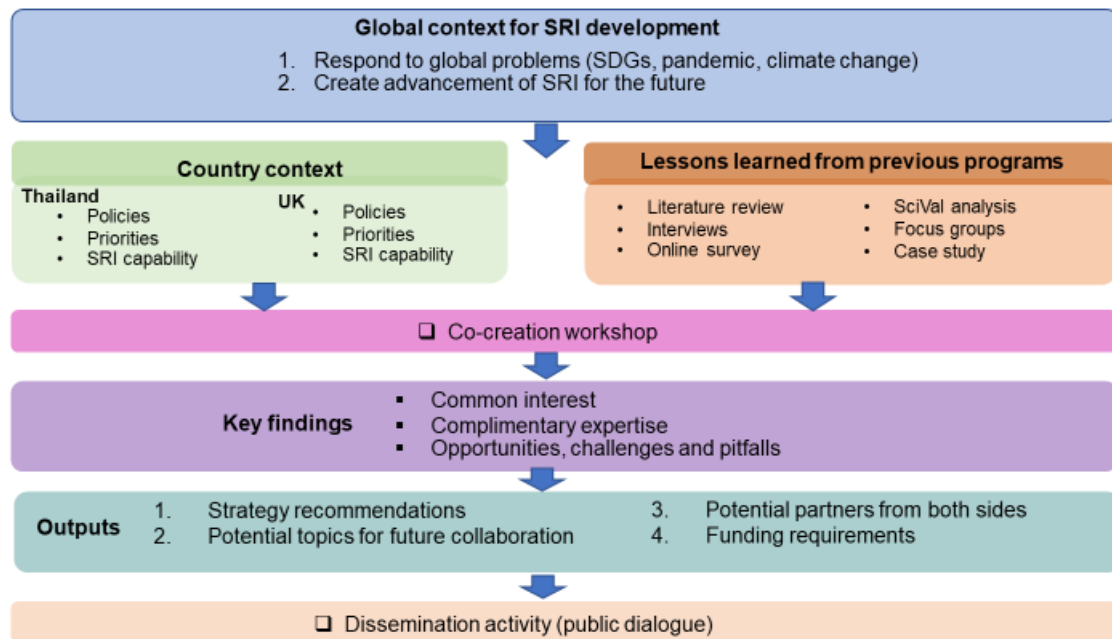


Figure 1.1 Conceptual Framework

The project's conceptual framework is based on identifying Thailand and UK policy priorities and SRI capabilities as well as gathering lessons learned from previous programs supporting SRI cooperation including the Newton Fund, the UK-Thailand Research and Innovation Partnership Fund, and the Global Challenge Research Fund (GCRF). This is also complemented with a literature review to identify policy priorities from both countries, a SciVal analysis to track trends in UK-Thailand SRI cooperation through the lens of academic publications, robust quantitative and qualitative data collection through an on-line survey and in-depth interviews, and focus group discussions to address challenges and opportunities for sustainable partnerships. The project concludes with developing recommendations that can inform the strategy for the next phase of UK-Thailand SRI cooperation.

The outcomes of this project, which include strategy recommendations, potential topics for future collaboration, potential partners from both sides and funding requirements were disseminated through a hybrid public dialogue meeting with key stakeholders from the UK and Thailand.

CHAPTER 2 LITERATURE REVIEW

2.1 The Status of UK Science, Research and Innovation (SRI)

Science, Research and Innovation (SRI) in the UK

The UK is one of the world's leading countries in SRI. In 2022, it was ranked 4th in the Global Innovation Index. Among sub-indicators, Creative outputs and Human capital and research aspects were ranked quite high in the 3rd and 6th places, respectively. In Human capital and research aspects, UK was doing well in QS university ranking, ranked 2nd. UK is home to four of the world's top 10 universities. The number of foreign tertiary-level students was 8.21 per 1000 inhabitants, ranked in 8th place. In Knowledge and technology output aspect, UK was ranked in the 1st place in the citation document h-Index and 3rd place in new businesses per thousand population aged 15-64. In addition, the number of publications produced in the UK since 2001 ranks 3rd in the world after the US and China. It can be seen that UK has quality human capital and research as input to generate valuable outputs in terms of publications and new businesses.

However, the UK still needs further improvement in some aspects; it is not doing well in the competitiveness ranking, where it occupied 23rd place in 2022, and ranked 18th for Technological Infrastructure and 14th for Science Infrastructure³.

UK's SRI Landscape

During the past decade, the SRI landscape in the UK has changed continuously, particularly in regard to the government departments responsible for SRI. In 2016, the Department for Business, Energy and Industrial Strategy (BEIS) was formed from the merger of the Department for Business, Innovation and Skills (BIS) and the Department of Energy and Climate Change (DECC) and assumed responsibility for business, industrial strategy, science and innovation, energy, and climate change.

In 2018, UK Research and Innovation was launched, which brought together seven disciplinary research councils. In 2023 the Department for Business, Energy and Industrial Strategy (BEIS) was replaced by the Department for Science, Innovation and Technology (DSIT). Foreign, Commonwealth, and Development Office (FCDO) also provides support through its Research and Evidence Directorate, grant funds for research to tackle developmental challenges.

The key actors that play an important role in the UK SRI system include government, universities, research institutes, government labs, private labs, funders, charities, and industries. Many of them are identified as research performing organisations (RPOs) that perform research activities involving both pure science and social science. Apart from the RPOs, other actors play different but vital roles in the landscape; a brief of key players and their roles in the UK's SRI landscape can be illustrated as follows:

1. **Government:** The main roles of government in the SRI landscape are policy deployment and budget allocation. The primary governmental unit that plays a vital role in this landscape is the Department for Science, Innovation and Technology (DSIT), which was established recently, in February 2023. DSIT works with 14 agencies and public bodies including the UK Research and Innovation (UKRI), which is the national funding agency investing in science and research in the UK. Other governmental departments involved in the SRI landscape include the Foreign, Commonwealth, and Development Office, Department for Environment Food & Rural Affairs, Department for Energy Security & Net Zero, Ministry of Defence, Department for Business & Trade, Department of Health & Social Care, and the Department for Work & Pensions.
2. **Universities:** Universities are the strongest sector of research-performing organisations in the UK. Higher Education Institutions (HEI) in England receive public funding via a dual support

³ The 2022 IMD World Competitiveness Ranking

system. Firstly, funding based on research activities conducted under these institutions is provided through block grants through Research England. Secondly, there are competitive grants, which are open to application from individual institutions. In Scotland, block grants are supported by the Research Excellence Grant and for Wales and Northern Ireland, the funding is from the higher education funding body.⁴

3. **Public sector research establishments:** This group of research institutions is supported by governmental units. They play an important role in the SRI landscape by providing critical science services for government, business, and society or delivering science advice to policy makers. Some of them excel in specific fields of research or frontier research, such as defence science, nuclear technology, and space technology, while others play a vital role in providing operational and regulatory functions for the country.⁵
4. **Funding agencies:** In recent years, the UK's Science, Research, and Innovation System has been reformed under the Higher Education and Research Act 2017. The Act established United Kingdom Research and Innovation (UKRI) to unify funding agencies for science, research and innovation. UKRI is considered to be the main funding source for support of science, research and innovation.

UKRI brings together seven disciplinary research councils, as well as Research England, which is responsible for supporting research and knowledge exchange at higher education institutions in England, and the UK's innovation agency, Innovate UK.

The seven UKRI councils are as follows:

- the Arts and Humanities Research Council (AHRC),
- the Biotechnology and Biological Sciences Research Council (BBSRC),
- the Economic and Social Research Council (ESRC),
- the Engineering and Physical Sciences Research Council (EPSRC), the Medical Research Council (MRC),
- the Natural Environment Research Council (NERC), and
- the Science and Technology Facilities Council (STFC).

The seven councils of UKRI provide competitive funding for project-based research.

Research England provides block grants, so-called Quality-related Research funding (QR), for universities in England for research and knowledge exchange activities. Innovate UK provides funding for entrepreneurs to translate research into innovation.

5. **National Academies:** National and devolved academies, including the Royal Society, the British Academy, the Royal Academy of Engineering, the Academy of Medical Sciences, the Royal Society of Edinburgh, the Royal Irish Academy and the Learned Society of Wales, are an important player in the UK science, research and innovation system. They play a role in retaining research talents and supporting the exchange of global research talents.
6. **Industry and Private sector:** This is the largest funder and performer of research in the UK. Multinationals involved in sectors such as automotive and pharmaceuticals are making significant investments in R&D, and there is increasing involvement in R&D by SMEs with specialised technical expertise.

⁴ Independent Review of the UK's Research, Development and Innovation Organisational Landscape. 2023

⁵ Guidance on assessing performance and value of Public Sector Research Establishments. 25 January 2022

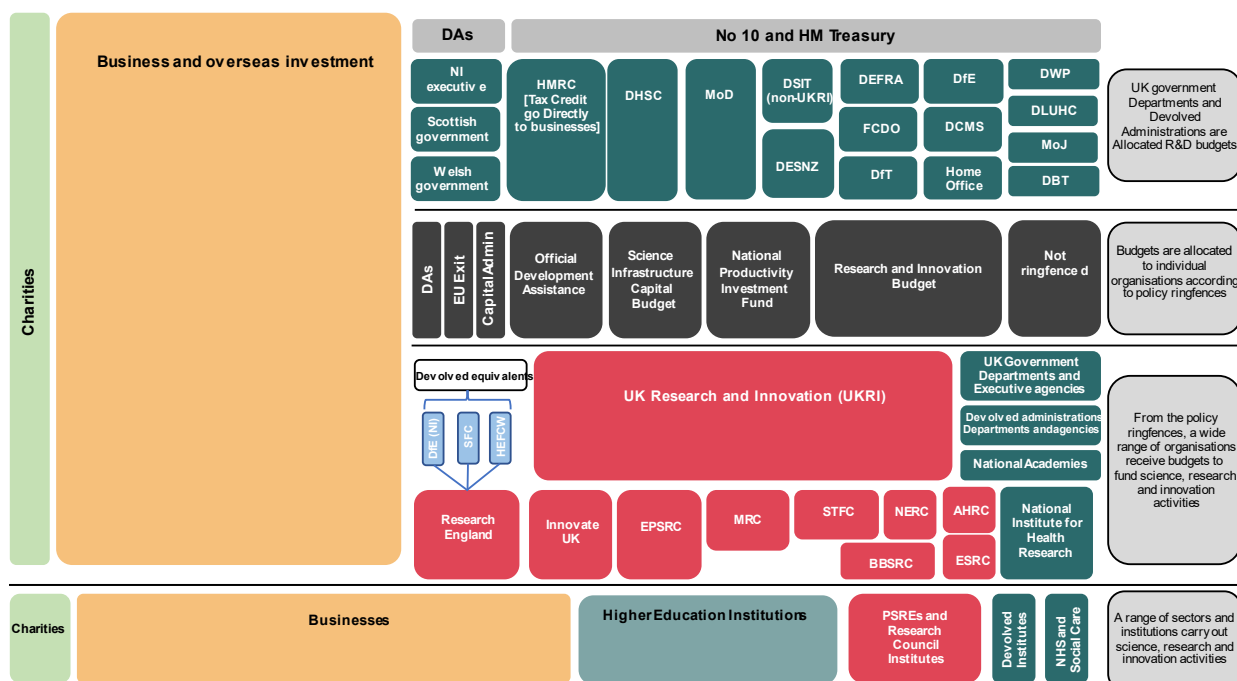


Figure 2.1 The UK funding landscape*

Source: adapted from UK Research and Development Roadmap**, 2020

***Acronyms:** DAs (Devolved Administrations), NI (Northern Ireland Executive), HMRC (HM Revenue and Customs), DHSC (Department of Health and Social Care), MoD (Ministry of Defence), DfE (Department for Education), DoT (Department for Transport), DEFRA (Department for Environment, Food and Rural Affairs), DWP (Department for Work and Pensions), MoJ (Ministry of Justice), HEFCW (Higher Education Funding Council Wales), SFC (Scottish Funding Council), DfE(NI) (Department for Economy (Northern Ireland)), EPSRC (Engineering and Physical Sciences Research Council), MRC (Medical Research Council), STFC (Science and Technology Facilities Council), NERC (Natural Environment Research Council), AHRC (Arts and Humanities Research Council), BBSRC (Biotechnology and Biological Sciences Research Council), ESRC (Economic and Social Research Council) PSREs (Public Sector Research Establishments)

****** There were some changes in UK departmental structures between 2020-2023. The BEIS (Department of Business, Energy and Industrial Strategy) was transformed into Department for Science, Innovation & Technology (DSIT), and the Department for Energy Security & Net Zero (DESNZ) in 2023, DfID (Department for International Development) was replaced by the Foreign, Commonwealth & Development Office (FCDO) in 2020, MHCLG (Ministry of Housing, Communities and Local Government) is now called Department for Levelling Up, Housing and Communities (DLUHC), DCMS (Department for Digital, Culture, Media and Sports) was replaced by Department for Science, Innovation and Technology (DSIT) and Department for Culture, Media and Sport (DCMS) in 2023, the FCO (Foreign and Commonwealth Office) replaced by the Foreign, Commonwealth & Development Office (FCDO) in 2020, and DIT (Department of International Trade) was replaced by the Department for Business and Trade (DBT) in 2023.

Relevant UK SRI Policies and Priorities

International Research and Innovation Strategy 2019

Before the COVID-19 pandemic, the UK Government published the International Research and Innovation Strategy 2019, which was part of the UK's Industry Strategy. This Strategy identified four Grand Challenges to build global partnerships, including Artificial Intelligence and Data, Clean Growth, the Future of Mobility and the Ageing Society.

As part of the Strategy, the UK Government set up a £110m Fund for International Collaboration. Such collaborations were seen as necessary to help the UK and other countries achieve their economic and social development objectives. This Strategy delivers not only by working with extensive diplomatic networks, such as Science and Innovation Network teams, UKRI, Newton and British Council offices, but also by promoting the role of universities and research institutions in building new partnerships. In addition, the strategy also aims to attract talented researchers to join UK and global research communities, help overseas researchers to create quality research with impact, and encourage UK researchers to boost international connections.

The strategy also wants to make UK the hub of international innovators, entrepreneurs, and investors, and to offer global platforms for new technologies by providing governance frameworks, innovative infrastructure, intellectual property, and global influence. There are several global research and development funds supporting the implementation of this Strategy, including the Newton Fund, Department for International Development, Global Challenge Research Fund, Fleming Fund, NIHR Global Health Research Programme, NIHR Global Health Research Programme, International Climate Finance and the Prosperity Fund.

UK Research and Development Roadmap 2020

In 2020 the UK Government launched the UK Research and Development Roadmap 2020, which aimed to strike a balance between discovery research and applied research. The goal was both to push frontiers of knowledge to create new technological breakthroughs by focusing on long-term discovery research driven by curiosity, and also to support applied research to tackle immediate challenges.

In support of discovery research, the Government created a new agile, innovative, and less bureaucratic funding agency called the Advanced Research and Innovation Agency (ARIA) to provide funding for advanced research, or moon shots, that develop breakthrough technologies. The UK also sought to maintain collaboration with the EU to develop UK's world-leading technologies, such as nuclear fusion.

The Roadmap focuses on translational research and applied research in new medicines and treatments, climate change and net-zero carbon emission. Also, the Government increased investment to build and strengthen collaborations with scientists, researchers, engineers, innovators and entrepreneurs across the world, and develop new funding approaches for collaboration to ensure that the UK will benefit from international scientific partnerships (HM Government, 2020).

UK Innovation Strategy 2021

In 2021, the UK Innovation Strategy was published. This Strategy aims to achieve results under four pillars. The first pillar is Unleashing Business, aiming to support private sector through financial supports, tax incentives, infrastructure, well-designed regulations, international trade and public procurement. The second pillar is People, aiming to make the UK the most exciting place for innovation talent. The third one is Institutions and Places, aiming to ensure that UK's research, development and innovation institutions serve the needs of businesses and places across the UK. The last one is Missions and Technologies, aiming to stimulate innovation to tackle major challenges faced by the UK and the world and drive capability in key technologies. This Strategy identified seven key technology families in which UK has a global advantage as follows: Advanced Materials and Manufacturing; AI,

Digital and Advanced Computing; Bioinformatics and Genomics; Engineering Biology; Electronics, Photonics and Quantum technologies; Energy, Environmental and Climate technologies; and Robotics and Smart Machines.

Council for Science and Technology (CST) 2021

After the COVID-19 pandemic, the UK Government set a goal for the UK to become a science superpower and innovative nation by 2030. To achieve this goal, in 2021 the CST⁶ advised the Government to increase investment in science, research and innovation, especially in the private sector, in order to achieve and maintain the country's status as a science and technology superpower.

The CST also recommended that the Government focus on strategic technology areas in which UK has a competitive advantage, use government procurement to promote innovation, attract global talent into business and academic sector, and support domestic and international research partnerships to tackle global challenges and security threats, such as climate change, pandemics, and digital privacy.

In addition, CST recommended that international research cooperation must align with the UK's priorities, complement each other's strengths, and secure foreign direct investment to build the UK's capability. The Council also advised the Government to build a new funding mechanism to support research and innovation partnerships. This mechanism should strike a balance between top-down mechanisms for country-to-country or funding agency to funding agency collaborations and bottom-up and multilateral collaborations (CST, 2021).

UK Science and Technology Framework 2023

The Government responded to the CST's recommendations with the Science and Technology Framework, which sets out their approach to making the UK a science and technology superpower by 2030. The Framework is built on the premise that science and technology will be the major driver of prosperity, power and history-making events this century.

In this Framework, the Government aims for the UK becomes a top three nation globally, on the basis of its science and technology system. Moreover, five critical technologies necessary to achieving superpower status were identified: Artificial Intelligence (AI), Engineering Biology, Future Telecommunications, Semiconductors, and Quantum Technologies.

The Government will also increase public investment in R&D, ensure the right diversity in the science and technology landscape, reduce the bureaucracy of research and innovation funding, establish competitive advantage in attracting international talent into the UK, and support innovative business through financial support and public procurement.

Importantly, the Government will prioritise science and technology-based international partnerships, define mutual benefits and explore new international collaboration funds. The Government will allocate £119 million for the International Science Partnership Fund, establish a UK Technology Centre of Expertise to support developing countries to transform their economies, and create partnerships with emerging and leading technology nations to build global resilience to shared challenges (Department for Science, Innovation and Technology, 2023).

⁶ In 2011, the Government transformed the National Science and Technology Council into the Council for Science and Technology (CST) which provides strategic leadership and coordination at the cabinet level. The CST advises the Prime Minister on science and technology policy issues across government. The council is an expert committee, which works with the Department for Science, Innovation and Technology.

UK International Technology Strategy 2023 (ITS23)

The UK's International Technology Strategy 2023 (ITS23) sets out the plans for the UK to become a technology superpower by 2030. ITS23 forms part of the wider Science and Technology (S&T) Framework. As part of this strategy, the Government announced £370 million funding to put the UK at the forefront of global science and technology.

ITS23 contains the roadmap which will be used to build on the UK's existing strengths in its technology sector. In 2022, the UK technology industry was estimated to be worth more than \$1tr and was home to the fourth largest number of tech unicorns globally, with more than 85,000 active start-ups and scale-ups⁷.

In the ITS23, technology will be used to promote economic benefits, democracy, stability and personal freedom and privacy around the world through four guiding principles:

- Open
- Responsible
- Secure
- Resilient

The UK will build alliances and partnerships to influence international standards and regulations to promote and protect innovation. In addition, the UK will establish a financial institution to invest in technology infrastructure in developing countries and a new Technology Centre of Expertise to share UK's knowledge for developing countries. Six strategies include: priority technology and data; international partnerships for global leadership; value-based governance and regulation; technology investment and expertise for the developing world; technology to drive UK economy; and protect UK's security interests.

According to these six strategies, the UK will develop a science partnership model between ARIA, UKRI and other bodies with similar institutions in other countries. Through multilateral bodies, the UK will share expertise for global good and influence the development, governance, and use of technologies. In addition, science diplomacy will be the channel to deliver this International Technology Strategy by investing in the UK's Global Science network, expanding the Tech Envoys network, and building capacity and capability on technology across FCDO. This Strategy identifies 6 technologies which need international collaboration, including: Artificial Intelligence, quantum technologies, engineering biology, semiconductors, telecoms, data (UK Government, 2023).

Integrated Review Refresh 2023

The Integrated Review Refresh 2023 was published following the Integrated Review 2021 because geopolitical threats have accelerated. These threats create new challenges, including energy security due to Russia's invasion of Ukraine, technology competition to create own technologies, such as AI and Chip, to reduce dependence of other countries, and technological threats and harm. More importantly, transnational challenges, including climate change and global biodiversity loss, are worsening and will be more severe over the next decade. Therefore, the thematic priority of the UK remains tackling climate change, environmental damage and biodiversity loss, and sustainable development. To contribute to sustainable development, the UK will reform the global financial system to be greener, make global tax systems fairer, deliver clean, green infrastructure and investment, improve global food security and nutrition, open science for global resilience, prevent the next global health crisis, and improve rights of women and girls. Recently, the UK became an ASEAN Dialogue Partner. In this review, the UK will align its efforts with ASEAN strategies. Recently, the new Department of Science, Innovation and Technology was established and takes responsibility for science and technology collaboration. Like the

⁷ <https://www.gov.uk/government/news/uk-tech-sector-retains-1-spot-in-europe-and-3-in-world-as-sector-resilience-brings-continued-growth>

UK Science and Technology Framework, five priority areas in which UK has strategic advantage are identified as follows: AI, semiconductors, quantum technologies, future telecommunications and engineering biology.

National Space Strategy 2021

In the National Space Strategy, the UK will support the application of existing advanced technologies, e.g., robotics, 3D printing, smart machines, advanced materials and manufacturing to AI, digital and advanced computing, to create new commercial markets, including in-space manufacturing, space travel and habitation, debris removal, in-orbit servicing and space-based energy. In addition, the Strategy also mentions that the Government plans to use space technologies, such as real-time satellite data and space-based solar power systems, to tackle global challenges, e.g., climate change, biodiversity loss and improving public services. The Strategy also states that the UK Government will promote international collaboration on R&D to keep pace with new technologies. In doing so, the UK Space Agency will deliver through collaboration among universities, industry, national and international organisations.

UKRI Strategy 2022-2027

Following the UK Innovation Strategy 2021 and CST's recommendations of 2021, UK Research and Innovation published the UKRI Strategy 2022-2027 to implement these strategies and recommendations. The UKRI Strategy is underpinned by four principles for change:

- **Diversity** in people, infrastructure, activities, skills, institutions, and ideas; connectivity by creating flow of knowledge and skills and support for collaboration;
- **Connectivity**;
- **Resilience** includes improving the financial resilience of research and innovation system and reduction of bureaucracy;
- **Engagement** by embedding research and innovation in society and economy.

The Strategy comprises six objectives, including making UK an attractive destination for talent, securing the UK's position as a global leader in SRI, advancing the frontiers of human knowledge and innovation, making the UK an innovation nation through the concerted actions of Innovate UK and wider UKRI, focusing the UK's world-class science and innovation to target global and national challenges, and making UKRI the most efficient, effective and agile organisation.

Strategic themes include: building a green future; securing better health, ageing and wellbeing; tackling infections; building a secure and resilient world; and creating opportunities and improving outcomes.

The Strategy also mentions that UKRI will take a strategic approach to international partnering through a renewed international strategic framework. In the UKRI International Strategic Framework, UKRI will forge new equitable partnerships, and deepen existing relationships with trusted partners to make the UK a collaborator and destination for international talent, innovative firms and inward investment.

In addition, UKRI will support the mobilisation of research and innovation strengths to tackle global challenges that require a global and coordinated response. To do this, UKRI will develop bilateral and multilateral funding programmes with international partners to support great ideas in areas of strategic priority. UKRI will continue to fund GCRF projects and R&D projects that address the SDGs under new funding programmes. UKRI identifies strategic advantage in key technology families, such as AI, quantum technology and engineering biology.

At the organisation level, several organisations published their strategies to help implement Government's strategies mentioned above. For example, the Royal Academy of Engineering Strategic Plan 2020-2025 states the aims and goals on sustainable society and inclusive economy which are to

be implemented through six major programmes in three dimensions. The first dimension, talent, and diversity, includes the UK Talent Engine Programme and the Future Skills Taskforce Programme. The second dimension, Innovation, includes the Innovation Catalyst Programme and the Global Challenge Engineering Programme. The third dimension, Policy and Engagement, includes the National Engineering Policy Centre Programme and the This is Engineering Programme. The Programmes opening opportunities for international collaboration are as follows: Innovation Catalyst; Global Challenge Engineering; and the National Engineering Policy Centre. The Met Office's Research and Innovation Strategy focuses on application of AI and Machine Learning, Next Generation Supercomputing, Cloud Technology and Data Analytics to enable weather and climate prediction to be more efficient and accurate.

In summary, most strategies aim to tackle global challenges, including climate change, environment damage, biodiversity loss, pandemics and infectious diseases, aging society, energy security and clean energy, net-zero emission, sustainable development, and digital privacy. These global challenges can be overcome through international collaboration. Moreover, these strategies identified the key technologies of the UK, which are detailed in Table 2.1 below.

Table 2.1 SRI Development Themes in UK Strategies

Framework/Strategy Technology/Theme	Year	Artificial Intelligence	Engineering Biology	Future Telecommunications	Semiconductors	Quantum Technologies	Advanced Materials and Manufacturing	Digital and Advanced Computing Data/ Data Analytics	Bioinformatics and Genomics	Electronics and Photonics	Energy, Environmental and Climate technologies	Robotics and Smart Machines	New medicines and treatments	Nuclear Fusion
International Research and Innovation Strategy	2019	✓						✓			✓			
UK Research and Development Roadmap	2020										✓		✓	✓
UK Innovation Strategy	2021	✓	✓			✓	✓	✓	✓	✓	✓	✓		
National Space Strategy	2021	✓					✓	✓				✓		
UK Science and Technology Framework	2023	✓	✓	✓	✓	✓								
UK International Technology Strategy	2023	✓	✓	✓	✓	✓		✓						
Integrated Review Refresh	2023	✓	✓	✓	✓	✓								
UKRI Strategy	2022	✓	✓			✓								
Met Office's Research and Innovation Strategy	2022	✓						✓						

Source: NSTDA, 2023

2.2 Review of SRI in Thailand

Overview

Thailand has demonstrated impressive progress in SRI over the past decade. Previously, Thailand faced a low level of R&D performance in terms of input, output measurement, and ranking. R&D expenditure per GDP (GERD) of Thailand during 1999-2011 was relatively low with an average of only 0.23%. Many studies have indicated that the poor performance was due to the weak and fragmented institutional system, poor linkages among important actors, and ineffective government fiscal and financial incentives in stimulating private sector investment in R&D. These weaknesses stemmed from following a conventional policy-making model for economic growth.

Previous National Plans, especially the Thai Government's 1st to the 8th National Economic and Social Development Plans (before 2001), did not give sufficient importance to SRI as a driver for socioeconomic development. Only under the 9th National Economic and Social Development Plan (2002-2006) were a number of changes initiated that emphasised collaboration in the SRI system, linking SRI to the country's competitiveness, and the participation of the private sector in R&D.

The 11th National Economic and Social development Plan (2012-2016) sought to create economic opportunities through a knowledge base, technology, innovation, and creativity, and it also set a GERD target at 1% of GDP.

Thailand's first National Strategy 2018-2037 focused on creating a balance between economic, social and environmental development. SRI has been embedded as a key mechanism to help boost the capacity of both public and private sectors, especially in a key strategy which aims to build Thailand's competitiveness and to empower human resources.

Since then, R&D expenditures per GDP of Thailand have risen from 0.37% in 2011 to 1.33% in 2020. The private sector's R&D contribution (BERD) is 68%, which is much higher than that of the public sector at 32%. Government investment in science and technology infrastructure also increased by 10% from the previous year (2019) because of the high investment in the Eastern Economic Corridor of Innovation (EECi). For the private sector, the most investment came from manufacturing industries, with the top three BERD in food, construction, and electrical equipment industries. Thailand has ambitiously targeted its GERD to rise to 2%, with a private sector contribution rising to 80% in 2037, and its number of researchers per 10,000 population at 25.

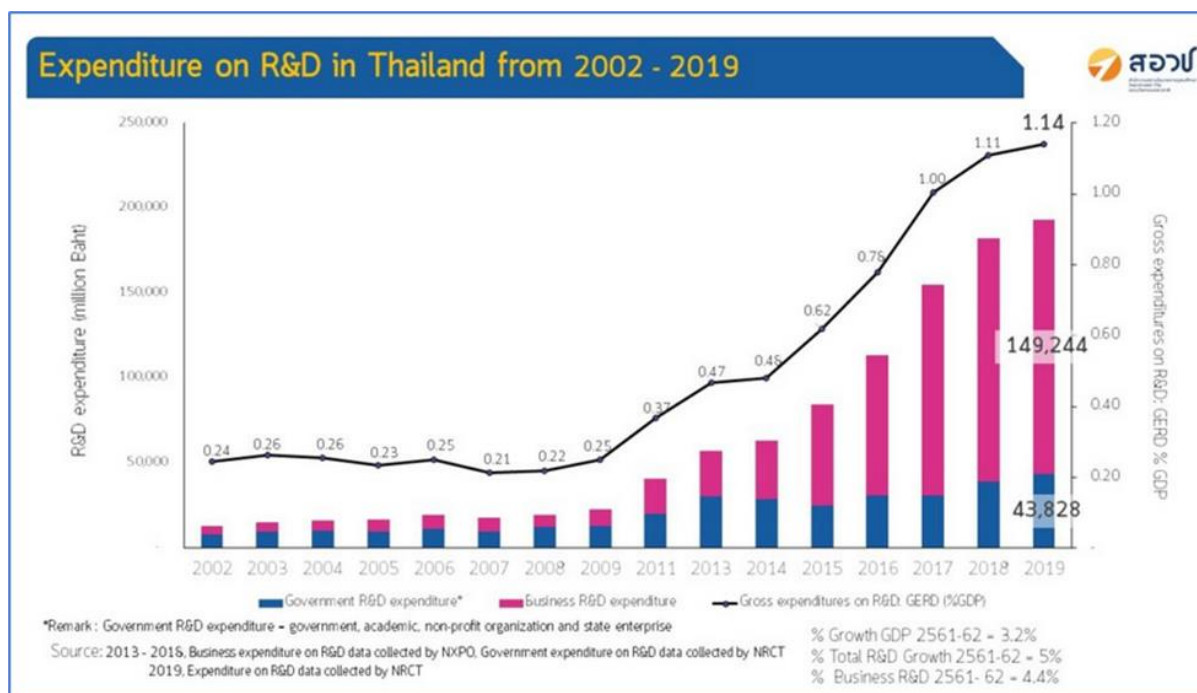


Figure 2.2 R&D expenditures per GDP (GERD) of Thailand from 2002-2019

Source: Office of National Higher Education Science Research and Innovation Policy Council
<https://www.nxpo.or.th/th/en/7981/>

Thailand's SRI Landscape

Thailand's SRI system was reformed in 2019 through 10 Acts which serve to guide higher education and SRI advancement in the country. The most important changes were the establishment of: (1) a new Ministry of Higher Education, Science, Research and Innovation (MHESI); (2) the National Higher Education, Science, Research and Innovation Policy Council, which is chaired by the Prime Minister and was formed to replace the previous National Research and Innovation Policy Council; (3) the National Commission on Science, Research and Innovation Promotion and Thailand Science, Research, and Innovation (TSRI); and (4) the National Science, Research and Innovation Fund (NSRF).

Figure 2.3 shows the structure of Thailand's SRI system after the reform. According to the Acts, the system must be comprised of organisations specifically assigned one of three roles: (1) policy, strategies and planning; (2) implementation, budget allocation and grant provision; and (3) operation. Each organisation in the system can only undertake one role to strengthen the SRI system, thereby avoiding conflicts of interest.

Policy Strategies and Planning

At the top level lies the new policy council with a mandate to direct the formulation of cohesive and systematic policy, strategies, and plans for higher education and SRI. The council therefore has a crucial role in proposing policy, strategies and plans to the cabinet, proposing the annual budget framework for higher education and SRI development to the cabinet, and allocating budget fairly and efficiently to around 170 SRI operating organisations in Thailand's SRI system. The Office of the Permanent Secretary (OPS) and the Office of the National Higher Education Science Research and Innovation Policy Council (NXPO) serve as the co-secretariat of the council.

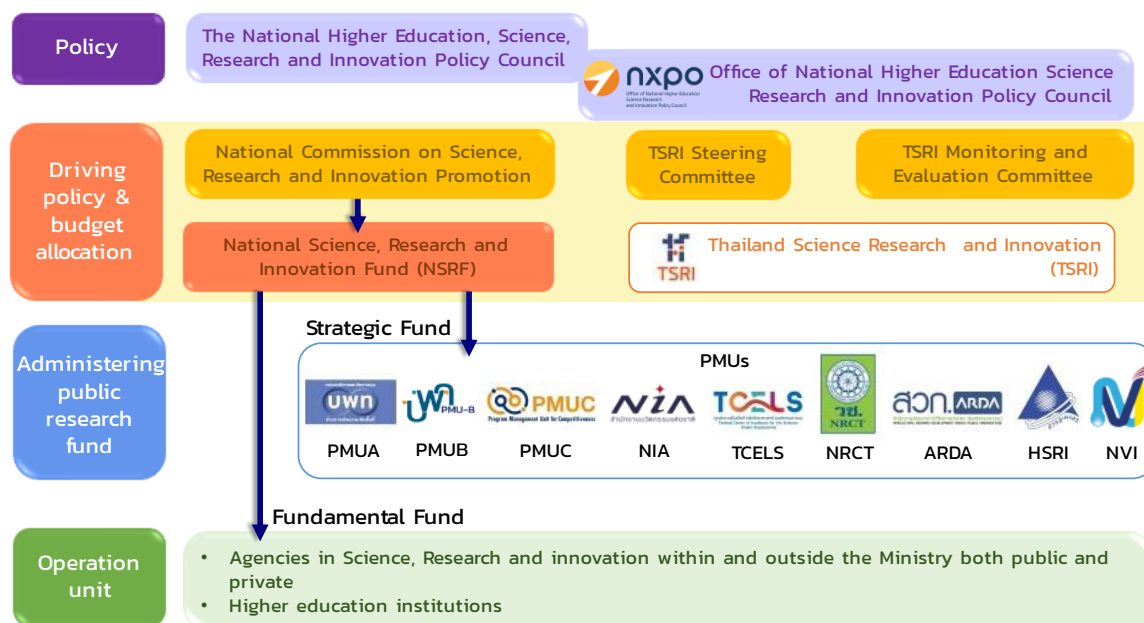


Figure 2.3 Structure of Thailand's SRI system after the 2019 reform

Source: adapted from TSRI August 2022

Implementation, budget allocation and grant provision

At the 'implementation, budget allocation, and grant provision' level, the National Commission on Science, Research and Innovation Promotion and its secretariat, Thailand Science, Research, and Innovation (TSRI) play an important part in the Thai SRI system. Their roles are to ensure that the approved SRI policy, strategies, and plans are efficiently implemented and eventually lead to the desired socioeconomic outcomes by utilising several mechanisms, including SRI policy formulation, budget allocation and grant provision, monitoring, and evaluation. One of the most significant is the establishment of the National Science, Research and Innovation Fund (NSRF) under TSRI. The NSRF functions as a unified fund for SRI development and promotion with the expectation of delivering socioeconomic impacts to Thailand. The fund itself is allocated into 2 tracks: a block grant for large-scale, infrastructure and long-term projects that will build STI capability (called the Fundamental Fund or FF, accounting for 35-40% of NSRF); and competitive grants through calls for proposals (under a mechanism called the Strategic Fund, or SF, which accounts for 60-65% of NSRF). SF is managed by nine funding agencies called Programme Management Units or PMUs, either established by the Act, or appointed by the council. Each PMU is responsible for a specific purpose, such as area-based development and inclusiveness, industrial competitiveness, SRI manpower development, or science advancement. The rationale behind the budget distribution by different PMUs is to diversify the areas for granting and avoid the domination of a single funding agency. Any organisation in the SRI system can apply to either scheme.

The nine PMUs and their responsibilities are as follows:

- National Research Council of Thailand (NRCT) - to provide funding for research and innovation in natural, social science, and humanities;
- National Innovation Agency (NIA) - to enhance the National Innovation System of Thailand to the international level focusing on the commercialisation of innovation;
- Agricultural Research Development Agency (ARDA) - to support sustainability and strength in agriculture by focusing on development of food production, solving natural resource problems in agro-ecology, and fostering a low-carbon society in the agricultural sector;

- Health Systems Research Institute (HSRI) - to enhance the stability of health system and build national capacity in genomics and precision medicine services;
- National Vaccine Institute (NVI) - to develop and produce a vaccine against COVID-19 and elevate status to be a center for vaccines at the ASEAN level;
- Thailand Center of Excellence for Life Sciences (TCELS) - to support the life sciences industry with a focus on genomics and precision medicine services, pharmaceuticals & regenerative medicine, advanced medical devices technology & medical robotics, advanced medical products, cosmetics and food supplements, and the health service system;
- Programme Management Unit (PMU) “A” (Area-based) - to develop the community or local area to enhance the quality of life and build the competitiveness of new entrepreneurs, micro-businesses, small and medium enterprises, community enterprises, and social enterprises at the local level;
- Programme Management Unit (PMU) “B” (Brain Power) manpower - to develop a high-performance workforce and frontier research and provide funding for the development of science and technology infrastructure;
- Programme Management Unit (PMU) “C” (Competitiveness) - to enhance national competitiveness by developing high-value goods and services to enter the global market. The focus area includes functional ingredients, high valued agricultural products, health foods, health and medicine, bioenergy or biochemical and biomaterials, creative tourism, digital platform, circular economy of Thailand, and future mobility, robotics, and automation.

Operation

The operational units are organisations that perform SRI, and they are classified into two types: (1) higher education institutes that are responsible mainly in producing SRI manpower, generating new knowledge, reskilling and upskilling services for important economic sectors and for society; and (2) agencies, both public and private, such as research and technology organisations (RTOs) that are performing full-time research and development relevant to the country’s demand, innovating, and utilising their outputs in economic sectors and society.

Currently, there are 173 higher education institutions⁸, of which 155 are either under, or regulated by, the Ministry of Higher Education, Science, Research and Innovation (MHESI). Agencies and other organisations whose activities support SRI activities are mainly performing research, providing laboratory services, metrology, calibration, testing, training, and upscaling research work to innovation to meet the country’s demands. Under MHESI are the Department of Science Service (DSS), Office of Atoms for Peace (OAP), National Institute of Metrology (NIMT), National Science and Technology Development Agency (NSTDA), Thailand Institute of Scientific and Technological Research (TISTR), Geo-Informatics and Space Technology Development Agency (GISTDA), Thailand Institute of Nuclear Technology (TINT), Synchrotron Light Research Institute (SLRI), National Astronomical Research Institute of Thailand (NARIT), and the Hydro-Informatics Institute (HII).

There are also some research institutes under other ministries, such as the Ministry of Defence, Ministry of Public Health, and the Ministry of Digital Economy and Society. They mainly perform research and development in relation to their ministry’s mission. Examples are the Defence Technology Institute (DTI), and the Department of Medical Sciences.

The expected output and outcome for both types of operation units are also different according to the nature of the work. While higher education institutes produce knowledge in the form of publications and intellectual property, the agencies are supposed to deliver impactful outcomes, such as strengthening the capability of public and private sectors, and communities. The agencies’ key performance indicators include increasing the number of technologies utilised in real sectors, growing socioeconomic impacts,

⁸ <https://data.mhesi.go.th/>

stronger networks and also strengthening their own organisation's SRI capabilities in potential areas that can be applied to Thailand's issues in the near future.

National Science, Research and Innovation Fund (NSRF)

The establishment of NSRF has forced organisations in the SRI system into adapting themselves because a large amount of national's SRI budget is now pooled at NSRF. Although each of the government's organisations still receives revenues each fiscal year in the form of direct appropriation funding from the Thailand Budget Bureau, the amount is significantly less than it was prior to the reforms. This budget only covers certain expenses such as staff, administration, and infrastructure investments.

To secure an adequate level of revenue and be sustainable, each organisation in the SRI system needs to adjust its plans and activities to be in line with the national SRI plan and submit them to the right channel of the NSRF's different tracks. Each year, TSRI, as the main NSRF management unit, proposes its budget allocation plan for NSRF to the National Commission on Science, Research and Innovation Promotion, and the Council and Thailand's Budget Bureau (BB), respectively. The whole process takes about one year, so needs to be initiated one year in advance; thus, for the fiscal year 2024 budget, the process started in August 2022 and involved the announcement of key dates and SRI budgeting frame, calling for proposals from all organisations, reviewing, defending and negotiation with the relevant committees. After the plan is approved by the cabinet, the budget is then released to PMUs (for SF) for the opening of calls for proposals, or allocation to organisations (for FF) as block grants.

Relevant Policies and priorities

After the SRI system reform in 2019, there have been several policy shifts. The two most important plans, the Higher Education, Science, Research and Innovation Policy and Strategy (2023-2027) of Ministry of Higher Education, Science, Research and Innovation (MHESI) and Thailand's SRI plan (2023-2027), were approved by the cabinet in December, 2022.⁹ They aim to be a blueprint for utilising the power of SRI and higher education to turn Thailand into a developed country by 2037.

SRI Plan and Strategies

Four strategies have been set to align with Thailand's long-term National Strategy (2017-2036). They target the value-driven and creative economy, sustainable social and environmental development, cutting-edge technology, and the development of manpower, higher education and research institutes. In the SRI Plan, 25 plans and 14 flagships are outlined with objectives, expected outcomes, and key results identified for each strategy and each plan.

The focus of the first strategy is to promote the role of SRI in enhancing the capacity of the private sector in the Bio-Circular-Green (BCG) economy model, which targets Thailand's competitive sectors such as agriculture and food, medical and wellness, bioenergy, biomaterial and biochemical, and tourism and creative economy. The BCG model is Thailand's national agenda to drive sustainable economic growth, social inclusiveness, and environmental sustainability. NSTDA, as a national agency for SRI development serves as the secretariat of the BCG Policy Board, chaired by the Prime Minister of Thailand to support, in both in science and network across the world, the development of innovative solutions for the country to achieve BCG targets. Flagships include the development and production of COVID-19 vaccines, Advanced Therapy Medicinal Products, functional ingredients, functional food, novel food, high-value food and fruits, and creative and sustainable tourism. Additionally, the plan targets sectors that are strategically important to Thailand's future economy such as Electric Vehicles (EV), digital technology, AI, smart electronics, logistics and rail transportation, and Innovation Driven Enterprises (IDEs).

⁹ <https://www.nxpo.or.th>, announced on 12 December 2022

The second strategy addresses the challenges that Thailand is facing, including aging society, healthcare, poverty and inequality, natural resources and environment, disaster, and climate change, whereas the third strategy gives priorities to SRI infrastructure and facilities. It also views technology as a game changer for new industries and services. The plan includes the advancement of Earth Space Technology to improve productivity in the agricultural sector, energy for the future, autonomous vehicles, and defence technologies.

The fourth strategy addresses weaknesses in Thailand's institutional structures, especially in SRI manpower and expertise. Hence, it aims to increase the number of scientists, researchers, innovators, and outputs from SRI activities quantitatively and qualitatively. Key results expected include the number of patents and publications in the first tier of international journals, improved Scimago Institutions Rankings of Thai research and technology institutes, and Thailand as the ASEAN¹⁰ hub of talent and knowledge. This strategy also mentions a flagship planned to promote collaboration in advanced research between research/academic institutes in Thailand and abroad, with several mechanisms, measures and infrastructures expected to encourage the mobility of talented international and domestic experts to Thailand.

Another plan to promote excellence in higher education and high skilled manpower development is the Higher Education Plan (2023-2027). Its strategies aim to balance the three pillars of development: capacity building, research ecosystem building and higher education transformation. Apart from the main objective to boost the academic output quantitatively and qualitatively and to feed high-quality SRI manpower in the system, it also mentions the priority areas of manpower development, such as those related to the four competitive sectors of BCG, aging society and climate change.

¹⁰ <https://asean.org/member-states/> The Association of Southeast Asian Nations (ASEAN) is a regional grouping that aims to promote economic, political-security and socio-cultural cooperation among its ten members: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam

Table 2.2 SRI Development themes/ priorities in Thailand

Framework/ Strategy	Year	Medical products	Genomic and medical services	Modern agriculture and food	Tourism and creative economy	Bio-based products	Clean energy and low carbon	Circular economy	Biodiversity	Smart city, factory and manufacturing	EV and modern logistics	AI, Smart electronics, robotics,	Physics, earth space and quantum tech	Government and service sector	Aging society	Social security	Climate change, crisis and natural	Talent, education and manpower	Humanities, social sciences and art
National Master Plan no. 23 - Research & Innovation	2018 - 2037	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	
National Economic and Social Development Plan 13	2023 - 2027	✓	✓	✓	✓		✓	✓		✓		✓		✓	✓		✓	✓	
Bio-Circular-Green (BCG) economy in action	2021 - 2027	✓	✓	✓	✓	✓	✓	✓	✓										
National AI strategy	2022 - 2027		✓	✓	✓		✓			✓	✓	✓		✓		✓	✓	✓	
HESRI policy and strategy	2023 - 2027	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SRI plan	2023 - 2027	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
Higher Education Plan	2023 - 2027	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓		✓	✓	✓

Source: NSTDA, 2023

Table 2.2 shows the Thailand's priority areas for SRI development. The National Master Plan No. 23 (Research & Innovation) and National Economic and Social Development Plan 13 are national-level policies that underlie SRI as a development mechanism in several sectors. The mapping of other SRI related plans indicates the importance of medical services, modern agriculture and food, clean energy and low carbon society. Apart from the bio-based industries, most SRI plans also put a high priority on tourism, AI, smart electronics, robotics, automation, climate change, crisis, disaster, and talent, especially that which will build capacity for Thailand.

2.3 UK-Thailand SRI Collaboration

It is to recognise that there are several different sources of funding that enables the UK to partner with Thailand on research. However, during the last decade, the Newton Fund and the Global Challenges Research Fund (GCRF), play an important role in forging UK-Thailand SRI collaboration.

Newton Fund

The Newton Fund, which was first implemented in 2014 to work with 18 partner countries, was a seven-year funding programme that was worth over £585 million. The fund was later expanded to £735 million following its earlier success. The fund was dedicated to support research and innovation activities between the UK and the partner countries to promote their economic, sustainable development and social welfare, often requiring matched resources from the partnering countries. The programme involved 2,000 partners and granted funding for over 5,400 projects.¹¹

In Thailand, the Newton Fund was initiated by a collaboration of SRI governmental units and funding agencies. The fund was categorised into 3 main pillars including the Research Pillar, People Pillar, and Translational Pillar. The Research Pillar was divided into subgroups of research topics of mutual interest such as infectious diseases, cancer, rice, swine and poultry, astronomy, impact of change on water resources, and the energy – food – water nexus. More than 40 projects were granted funding under this pillar.

For the People Pillar, there were 6 programmes involving Advanced Fellowships, Mobility grants, Professional Development for Mid-career Researchers and Officers, PhD programmes, Researcher Links (travel grants and workshops), and STEM education. The last pillar, Translational Pillar, comprises 4 programmes, including Institutional Links, Leaders in Innovation Fellowship (LIF), Industry-Academia Partnerships (and later called Transforming Systems Through Partnerships), and Newton Fund Impact Scheme.

Throughout the 7-year implementation of the Newton Fund, as many as over 2,000 researchers benefited from the fund, from capacity building on different skills, knowledge exchanges, to joint collaborative projects between the two countries. There was also trilateral engagement, which contribute to a small proportion.

Global Challenges Research Fund (GCRF)

The second programme is the Global Challenges Research Fund or GCRF, which was first announced in 2015. This fund aimed to support research on the challenges faced by developing countries. The awarded projects were collaborative projects between institutions in developing countries and the UK. The research themes for the GCRF were identified regarding the UK Aid Strategy and the UN SDGs, and specified 3 main topics: Equitable access to sustainable development; Sustainable economies and societies; and Human rights, good governance and social justice.¹² For Thailand, only a small number of projects received support from this programme. The data for 2023 shows only 4 research projects awarded by the GCRF.

In addition to the UK International Funds, joint publications also provide retrospective insights into the scientific partnerships between the two countries. Therefore, SciVal Analysis tool was selected to analyse number of joint publications which were published by the UK and Thai researcher teams within the ten-year period between 2012-2021. Furthermore, the number and topic of co-publications between the two countries were also examined to see SRI capability of the UK-Thailand collaboration in that past 10 years.

¹¹ Evaluation of the Newton Fund- Final Report, February 2022

¹² Growing research capability to meet the challenges faced by developing countries, July 2017

Number of Publications, Co-publications, Topic clusters, Institutions (SciVal Analysis)

Table 2.3 Number of publications from Thailand and the UK in 2012-2021

Year	Thailand	UK
2012	12,395	195,295
2013	12,611	207,769
2014	13,725	200,451
2015	13,297	206,946
2016	15,094	221,031
2017	17,013	228,413
2018	19,265	231,681
2019	20,453	227,324
2020	22,037	230,784
2021	25,245	246,167
Total	199,411	2,433,827

The data shown in Table 2.3 shows the number of publications from the UK and Thailand published from 2012 to 2021. Although, the number of publications from Thailand was increasing more than 100 percent within 10 years while the UK had a 26 percent growth; there is a big difference in number of publications produced in the UK and Thailand during the last decade. In 2012, the number of publications from the UK is over 15 times higher than Thailand. In 2021, the gap became smaller, though there was still almost a tenfold difference between the two countries.

Source: NSTDA (SciVal analysis tool), 2023

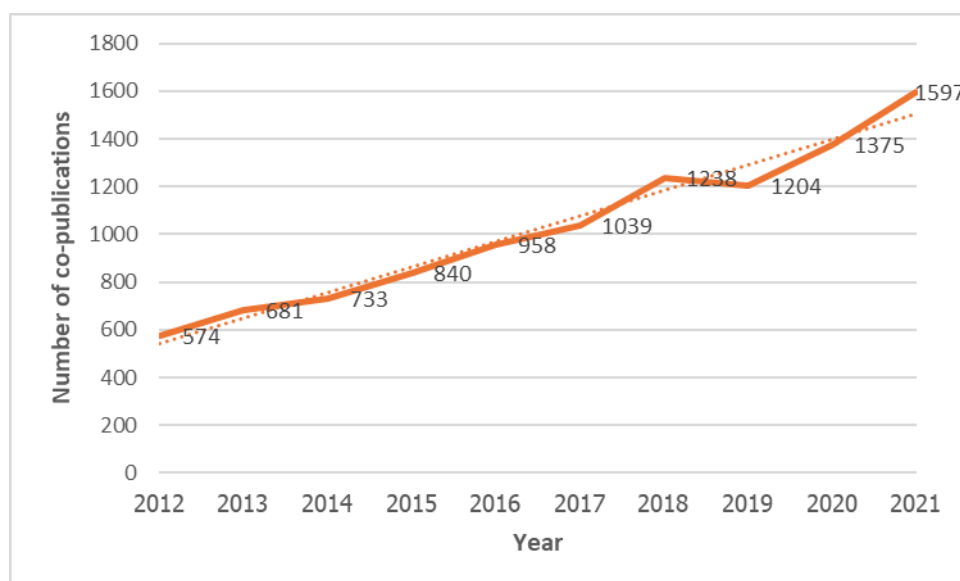


Figure 2.4 Number of UK-Thailand co-publication in 2012-2021

Source: NSTDA (SciVal analysis tool), 2023

Table 2.4 Top 10 topic cluster of UK-Thailand co-publication in 2012-2021

Ranking	Topic Cluster	Co-Publication
1	Decay, Quarks, Neutrinos	1,189
2	Malaria, Plasmodium Falciparum, Parasites	741
3	Dengue, Viruses, Dengue Virus	174
4	HIV, HIV Infections, HIV-1	171
5	Cystic Fibrosis, Cystic Fibrosis Transmembrane Conductance Regulator, Pseudomonas Aeruginosa	157
6	Galaxies, Stars, Planets	152
7	Anti-Bacterial Agents, Infection, Methicillin-Resistant Staphylococcus Aureus	148
8	COVID-19, SARS-CoV-2, Coronavirus	114
9	Human Influenza, Orthomyxoviridae, Influenza Vaccines	114
10	Echinococcosis, Schistosomiasis, Parasites	103

Source: NSTDA (SciVal analysis tool), 2023

In Figure 2.4, the data on the bar chart illustrates the number of UK-Thailand co-publications from 2012-2021. The number of co-publications in 2012 was small in comparison to that from the year 2021, however the number had increased significantly by 2016, when it was almost double the number of 2012. Publications produced by researchers in both countries increased significantly every year until 2021, which was 1.6 times higher than 2012.

One possible explanation for the significant increase in the number of co-publications in 2016 is the introduction of the Newton Fund in 2014. It cannot be said that the number of co-publications increased as a direct result of the Newton Fund but there might be some correlation between the increased number and the launch of Newton Fund.

Table 2.4 demonstrates the top 10 clusters of research topics in co-publications published by the two countries. Seven of the 10 topics concern infectious diseases, and two of them are related to space and physics. These two topics are under the Research Pillar of the Newton Fund implemented in Thailand.

Data Analysis and Conclusions

Key findings based on data analysis show a number of common priorities and technologies shared by both the UK and Thailand. Though there remains a significant difference in SRI capacity between the two countries, with UK researchers producing ten times the number of publications than Thai researchers, there are some common interests in the cluster of research topics that have been published, such as algorithms, computer vision and models. The publication data from the last three years shows a common interest in COVID-19, SARS-CoV-2, and Coronavirus as the top 3 research topics from both countries. This common interest leads to a further collaboration between UK and Thailand in technology transfer for production of COVID-19 vaccine in Thailand.

The UK Science and Technology Framework identifies five priority areas including AI, semiconductors, quantum technologies, future telecommunications, and engineering biology. In comparison, Thailand focuses on national policies, including the Thirteenth National Economic and Social Development Plan (2023-2027), which concentrates on 13 pillars. These consist of: high value added agriculture; sustainable and high quality tourism; electric vehicles; health and wellness; digital and smart electronics; circular economy and low carbon society; mitigation of natural disaster and climate change; the national plan for AI strategy; and the Action Plan for Bio-Circular-Green Economy (BCG) model,

which targets 4 main sectors concerns (agriculture and food, medical and wellness, bioenergy, biomaterials and biochemicals, and tourism and creative economy).

In considering both SRI capacity and national priorities, the data demonstrate some potential collaborative topics that might be included in the next phase of UK-Thailand collaboration. However, further data and analysis is required from an online survey, in-depth-interviews, and co-creation workshops to explore these potential topics further and inform strategy recommendations for future collaboration between the UK and Thailand in SRI.

CHAPTER 3 METHODOLOGY

The project aims to provide the evidence needed to develop strategy and policy recommendations for the next phase of UK-Thailand cooperation. Therefore, this chapter describes the research methodology used to explore in further detail the topics identified as having potential for future collaboration between the UK and Thailand in SRI, and informing strategy recommendations. Figure 3.1 provides an overview of the research methodology.

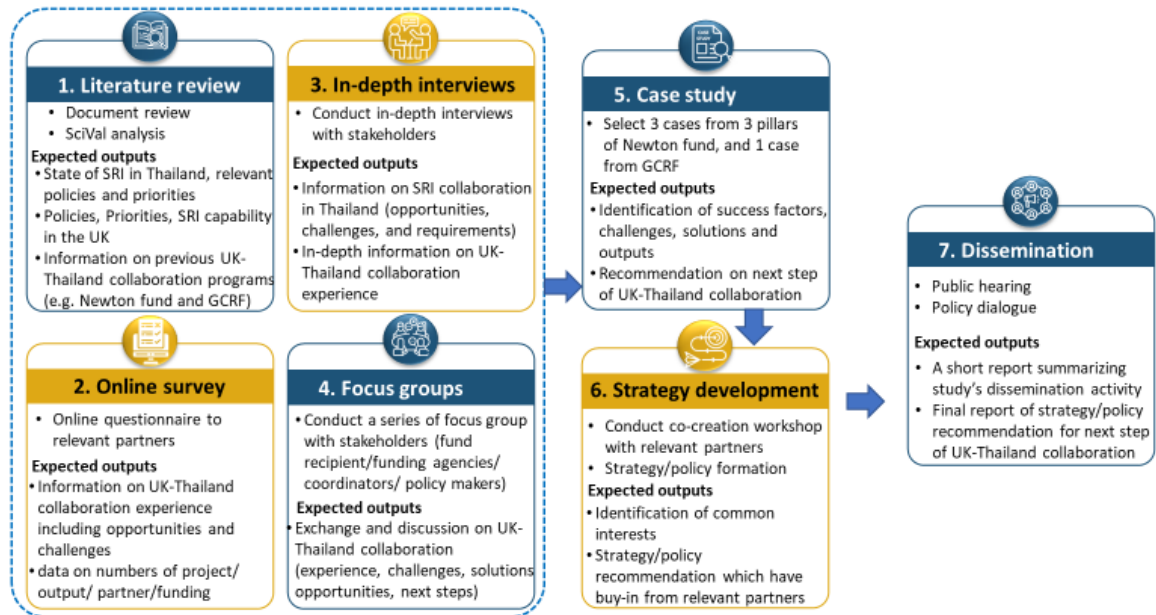


Figure 3.1 Research Methodology

To collect and analyse primary data, the CIPP Model was used as a framework to evaluate previous Thailand-UK collaboration. CIPP stands for context, intput, process and product evaluations and their definitions are as follows:

- Context evaluation is used to define institutional/service context, diagnose problems and needs, identify assets and resources, and assess goals to respond to needs;
- Input evaluation is used to identify and assess system capabilities. It considers programmes, interventions, resources, and means of plans, which bring benefits or meet needs;
- Process evaluation is used to identify and predict defects. It considers implementation of plans, feedback, lessons learned, obstacles and challenges during the implementation of plans;
- Product evaluation is used to collect outcomes. It considers achievements, outputs, outcomes and impact.¹³

Following the CIPP Model, interview guideline questions and a questionnaire were designed to collect primary data through interviews and the online survey, as follows:

¹³ Stufflebeam, D.L (2000). The CIPP Model for Evaluation. In: Stufflebeam, D.L., Madaus, G.F., Kellaghan, T. (eds) Evaluation Models. Evaluation in Education and Human Services, vol .49Springer, Dordrecht. https://doi.org/6-47559-306-0/10.1007_16

CIPP Evaluation	Interview Questions	Questionnaire for online survey
Context evaluation	- Has/Have your organisation/you ever participated in Thailand-UK collaboration? - Which programmes has/have your organisation/you participated in? Newton Fund? GCRF? Other? - What were the objectives of the collaboration?	- Has/Have your organisation/you ever participated in the UK-Thailand collaboration scheme on science, research and innovation? - To what extent has the Newton Fund/ GCRF complemented and/or contributed to the work of other stakeholders? - Do you think the Newton Fund/ GCRF have achieved their objectives? - What are the benefits you (researchers) received from the UK-Thailand collaboration programmes?
Input evaluation	- Please explain about the collaboration. - How did your organisation finance the collaboration? Matching fund or grant? - How much did your organisation pay for the collaboration (if any)?	Which funding programme did your organisation participate in?
Process evaluation	What were challenges/obstacles during the implementation of the collaboration project(s)?	- To what extent was the Newton Fund/ GCRF delivered efficiently? - What challenges/obstacles did you encounter in these programmes?
Product evaluation	- Do you think the collaboration has been successful? - What were the outputs and success/failure factors?	Are the benefits you achieved from the Newton Fund/ GCRF likely to be sustained?

Task 1: Literature review and data collection

Task 1 aims to identify relevant policies, priority research issues and SRI expertise from the two countries. The activities therefore included: (1) collection of key documents, which include national policy, SRI policy, national agenda (e.g., BCG, national AI agenda), SRI capability; and (2) SciVal analysis to evaluate research performance, collaborative partnerships, and research trends from the past UK-Thailand research collaboration. The outputs from this task are an assessment of SRI capacity, as well as relevant policies and research priorities for the UK and Thailand as shown in Chapter 2. The review includes information on previous UK-Thailand collaboration programs focusing on Newton Fund and the GCRF.

Task 2: Online survey

To obtain information from relevant stakeholders, an online questionnaire covering past experiences in UK-Thailand collaboration, types of collaborative project, collaboration partners, role in collaboration, collaboration outputs, opportunities and challenges, and future plans for collaboration, were circulated

to approximately 700 participants. Target participants included Newton Fund and GCRF grantees, funding agencies, researchers, and Newton Fund/ GCRF partners from both sides.

Task 3: In-depth interviews

In-depth interviews were conducted to obtain detailed results from four stakeholder groups: funding agencies, grantees, organisations of grantees, policy makers and governmental agencies. More than thirty people were interviewed on their experience in research collaboration, opportunities, challenges and pitfalls, suggestions and requirements for sustainable and successful UK-Thailand collaboration in the future. This task was expected to deliver information on SRI collaboration in Thailand (opportunities, challenges, and requirements), as described in Chapter 4. A list of participants in in-depth interviews is shown in Appendix III.

Task 4: Focus groups

Four hybrid (both online and on-site) focus groups were conducted to collect data through group interaction. Three groups represented one of each of the three pillars of the Newton Fund (People, Research, Translation) and one group from GCRF. Participants in each group included representatives of relevant stakeholders. The focus groups allowed information exchanges and in-depth discussion on UK-Thailand collaboration, containing collaboration experience, challenges, opportunities, and recommendations on next steps for future collaboration.

Task 5: Case studies

One case study was selected from each of the four focus groups: 3 cases from the three pillars of the Newton Fund (People, Research, Translation) and 1 case from GCRF. This task contributed a summary of strategic recommendations on the next steps of the UK-Thailand collaboration and identified success factors, challenges, solutions, and outputs from the UK-Thailand collaboration, as shown in Chapter 4 Section 4.3.

Task 6: Strategy recommendation development

Before formulating the final strategy recommendations, a hybrid co-creation workshop was conducted to shape the individual recommendations. A total of 74 participants, representing relevant partners, including previous grantees, funding agencies, delivery units, policy makers, and governmental agencies from both sides, were invited to join the workshop. The information collected from the previous five tasks was presented to the workshop participants, and they were asked to provide their feedback and make recommendations for the next phase of UK-Thailand collaboration. At the end of the workshop, draft strategy and policy recommendations were prepared, as shown in Chapter 5.

Task 7: Dissemination

The outcomes of this project were disseminated through a hybrid public dialogue meeting comprising at least 50 participants representing key stakeholders from UK and Thailand, such as previous grantees, funding agencies, delivery units, policy makers, governmental bodies, and other researchers. During this meeting, key findings as well as the strategy recommendations were presented followed by a public discussion, which help shape the final report of this project. After the public dialogue, the current comprehensive report will be prepared, concluding the multidimensional strategy/policy recommendations for the next step of UK-Thailand collaboration to ensure sustainability and success of the program.

CHAPTER 4 RESULTS AND FINDINGS

4.1 Online survey

Overall, there were 190 respondents to the survey, accounting for 24% of all questionnaires sent out. There were 140 respondents from Thailand, 41 from the UK, and 9 who did not specify their country. The respondents can be divided into two groups: 171 researchers; and 19 funders/ delivery partners. Respondents comprised 100 males (53%), 80 females (42%) and 10 of unspecified gender (5%). Details are provided in Appendix IV.

The results from questionnaire were analysed after data cleaning using both descriptive, and inferential statistical methods. The main contribution from the survey was to provide information on past experiences from participants of UK-Thailand collaboration, and feedback identifying opportunities and challenges for future collaboration, as described in Chapter 3. The detail on responses to selected questions is demonstrated in Table 4.1 and Table 4.2.

Table 4.1 The detail of answers to the questions from online survey

Group of respondent/ Question	Responses to each question
Funding Agencies/ Delivery partners	
To what the Newton Fund/ GCRF complemented and/or contributed to the work of other stakeholders (e.g., grantee, government agency, delivery partner)?	- 15.6% Much more than expected - 50% Somewhat more than expected - 34.4% As much as expected
Do you think the Newton Fund/ GCRF have achieved their objectives?	- 50% Strongly agree - 50% Somewhat agree
To what extent was the Newton Fund/ GCRF delivered efficiently?	- 34.4% extremely efficient - 65.6% Somewhat efficient
What challenges/obstacles did you encounter in these programmes? (Multiple answers can be applied)	- Funding: 0% Yes, 100% No - Research collaborating partners: 33% Yes, 67% No - Timing: 50% Yes, 50% No - Other factors: 33% Yes, 67% No - Process: 33% Yes, 67% No
Do you think the benefits by the Newton Fund/ GCRF likely to be sustained?	- 83% Yes - 17% No
Would you like to participate in the next phase of the UK-Thailand collaboration programme?	- 100% Yes
Researchers	
To what extent was the Newton Fund/ GCRF been successful in overall?	- 47% Extremely successful - 53% Somewhat successful
What are the benefits from the UK-Thailand collaboration programmes? (Multiple answers can be applied)	- 33% for enhanced R&D network - 31% for access to new sources of knowledge - 30% for built long term partnerships to tackle Global Challenges - 27% for improved research quality and standards - 27% for participation in a multidisciplinary research collaboration - 26% for strengthened translational research skills - 17% for increase in number of publications - 13% for access to research equipment and infrastructure

Group of respondent/ Question	Responses to each question
	- 2% for others, e.g. access to novel plant genetic resources, credibility gained from working with a leading UK academic institution, training young staffs in UK
What are the challenges/obstacles in UK-Thailand collaboration? (Multiple answers can be applied)	- Funding: 50% Yes, 50% No - Research collaborating partners: 25% Yes, 75% No - Timing: 25% Yes, 75% No - Other factors: 23% Yes, 77% No - Process: 12% Yes, 88% No
Would you like to participate in the UK-Thailand collaboration programme in the next phase?	- 92% Yes - 8% No

Table 4.2 Challenges/obstacles from previous UK-Thailand collaboration

PARTNERS	PROCESS	TIMING	OTHERS
- High overhead cost of UK partners - Budget allocation was not in accordance with the proposal - Take time to find partners and difficult to match interests - Different attitude, culture and understanding - Change research members - Need existing partners - Need more mentors in LIF programmes - Different IP arrangement and management	- Complexity of assessment process - Take time to understand process of Newton Fund - UK regulation takes long time to proceed - Different report requirement led to loss of cohesion - Unconstructive funding management in Thailand caused delay in research activities - Different criteria of project selection between UK and Thai committee - University supports are not well-aligned with UK system	- Pandemic of COVID-19 caused delay in research activities - Project duration is too short - Too short time to prepare application - Slow UK funding cycle may kill research momentum - Timing of research contracts between UK and Thailand sides are not matched, leading to the delay - Different fiscal years of UK and Thailand caused the difficulty in budget allocation	- Brexit caused funding to be limited - COVID-19 leads to terminations of projects due to insufficient funding and disruption of research activities

4.2 In-depth interviews

The research team conducted in-depth interviews with a total of 33 Thai and UK stakeholders, of whom 21 were representatives of delivery partners/funding agencies, and 12 were researchers (further details are included in Appendix III). The purpose of the interviews was to obtain information about collaborative partners who have previously conducted joint research, have work experience in UK-Thailand collaboration, obstacles/challenges, including problem-solving solutions, opportunities received from the past activities, as well as suggestions for the next phase of cooperation between UK-Thailand, comprising both funding mechanisms and suggested research topics. These data will be analysed together with data obtained from the online survey and that obtained from the 4 focus groups, as described below.

4.3 Focus group and case study

A total of 95 people participated in the 4 focus groups, 80 of whom were from Thailand and 15 from the UK. The first meeting comprised 16 representatives from fund recipients and coordinators of 5 projects funded by GCRF. The second meeting involved people funded under the Newton Fund pillar. There were 26 participants, representing grantees and delivery partners from the different programmes supported under this pillar. The third meeting consisted of representatives from the Translation pillar group, with 25 participants representing the grantees and coordinators of the four sub-programmes under the Translation pillar. The 4th, and last, focus group meeting, represented the Research pillar group. There were 28 participants in this meeting, consisting of 4 groups of representatives from researchers and delivery partners under the research theme. In 4 subgroup meetings, brainstorming and discussions were held to exchange views on each person's experience in implementing research activities under the UK-Thailand collaboration, including suggestions on the next phase of collaboration covering both the funding process and suggested research topics for support. After that, the research team compiled the data from the 3 components of the research, namely the online survey, in-depth interviews, and focus groups, and analysed the findings together with building case studies for all 4 groups, as follows:

People Pillar

The People pillar is a personnel development component covering grants for continuing education, short-term researcher exchange, as well as capacity development of researchers, for example, Ph.D. Placement Grants, which are scholarships for students and advisors under the Royal Golden Jubilee Ph.D. Programme, the Research and Researchers Funds for Industries, the International Research Network (IRN), and the Newton Advanced Fellowships, which awards grants to researchers who have completed a Ph.D. not more than 15 years ago (mid-career researchers) to develop research strength and research cooperation with researchers from the UK. The Newton Mobility Grants fund new generation researchers (Young Researchers) to exchange research and innovation at UK universities, in collaboration with UK researchers. To further develop national development activities, Researcher Links Grants provide scholarships to young researchers from both the UK and Thailand to build international networks through workshop and travel grants. The Professional Development Fund provides scholarships for middle-career researchers from Thailand (researchers with between 5-15 years' experience) to develop research management skills and develop inter-country cooperation. Focus Group participants saw the People Pillar as very important and useful, especially the Mobility Grant, which is one of the components contributing to the success of the Research pillar, in particular the Multidisciplinary project.

Several challenges were noted by the focus group participants. These included COVID-19, which made it impossible to organise workshops to transfer knowledge, with online meetings not as effective as needed. Some projects lacked continuity because project participants in the UK changed jobs or moved to different departments. Regulations for the use of agency funds are complicated, especially in the government bureaucratic system, and the fiscal years of Thailand and the UK do not match, causing projects to end at different times. In addition, the Thai and UK review systems are different, and in some projects the Thai and UK reviewers had different opinions and it was necessary to reach consensus.

Focus group participants suggested that there should be more such support programmes, based on a long-term plan of 5-10 years and providing continuous funding for 3 years, in order to open opportunities for cooperation, joint research and technology transfer. Consideration should be given to measurement of results in other dimensions apart from research publication, such as technology development and personnel development. Also, participants wanted the selection of topics to be open and flexible, but still aligned with the national programme according to the Strategic Plan of Thailand Science Research and Innovation (TSRI), and must also be consistent with that of the UK. Regarding this concern, researchers need to be informed of these conditions during promotion of the programme. Participants wanted an overview made of all topics without separating them according to the

responsible PMU. Topics that support human development should not be limited to research themes, as is done with the Research pillar, but should be open to the development of work in a variety of fields, especially areas of social science that are important and can help promote the utilisation of natural science work. A network should be set up of people who have received support from the Newton Fund. In the area of management, there should be clear financial guidelines for the various agencies in Thailand and the UK.

Case study: Multiplier effect from People pillar to Research pillar

This example concerns a researcher who received funding under the People programme who successfully developed the research and development industry in Thailand, resulting in cooperation and building of international networks through the relationship with UK university experts. The researcher received continuous research funding from the People programme, which led to research funding from the Research Programme.

A researcher from Mahidol University who received a Ph.D. at the Medical Research Council Laboratory of Molecular Biology (MRC-LMB), University of Cambridge, was interested in the field of genetic expression in response to environmental changes that leads to biodiversity. A researcher from the Sanger Institute, which has pioneered the application of single cell technologies, served as an advisor. This researcher received a Professional Development Grant, which provided training to develop research and development management skills and development of international collaboration through support from the Thailand Research Fund (TRF) and the British Council. In 2016 the researcher received Mobility Grants funding from the support of the Office of the Permanent Secretary for Higher Education, Science, Research and Innovation (OPS) together with the Royal Society. The research, predicting transcription factor binding modes and gene expression using integrative analysis, was funded by a Newton Advanced Fellowship with researchers from the Sanger Institute in a joint sponsorship between the Royal Society, and the Thailand Research Fund (TRF) to study the relationship of proteins, transcript factors and histones at the cellular level (single cell resolution). As a result, the researcher became a leader in the single-cell genomics technique for sequencing analysis, the first time this had been used in Thailand.

Joint work with the project leader, another senior researcher from Mahidol University, led to a 2018 grant from the Health Group's Newton Fund Research Programme from NSTDA and MRC for a study "Dissecting global protective immune response to dengue virus at a single-cell-resolution".

In addition to driving investment in scientific equipment of the Faculty of Science, Mahidol University, for the first-time use in Thailand of single-cell genomics analytic techniques, the success of receiving research grants from the People programme also extends research into the area of precision medicine. This field, which comprises in-depth analysis to study the genetic structure to the cellular level with single-cell omics technology, is currently being used to create a map of genetic diversity, the Asian Immune Diversity Atlas (AIDA).

This case study shows a multiplier effect from funding under the People pillar in linking large-scale funding through the Research pillar, as well as developing the advanced research capabilities of Thailand and the investment in research infrastructure of universities in Thailand.

Case study: Research in Social Science for policy making

This case study presents the example of a researcher in field of social science from the Open University who has networked with Thai researchers since studying for a doctorate at the University of Bath. The researcher's connection with the network of social science researchers in Thailand was made through funding from the Newton Fund's Researcher Links in the Travel Grants division in 2017 with the support of the British Council in conjunction with the Thailand Research Fund (TRF). The grant allowed the researcher to work in Thailand for a period of 8 weeks, conducting research in collaboration with foreign expert lecturers at the Faculty of Social Work, Thammasat University on a project on child welfare and care for vulnerable children entitled "The transition from orphanages to foster care in Thailand: a study that explores how child welfare interventions are transferred internationally and implemented across cultures". The project was very successful, commencing with funding support that enabled the research team to have the opportunity to work with various stakeholders, including NGOs and related government agencies in Thailand.

During the stay in Thailand the researcher lectured at various universities, such as Prince of Songkla University, Thaksin University Phatthalung Campus, and Thammasat University, as well as giving a public lecture on child welfare and childcare, which has been well received. The research team that worked together received additional funding from the Foundation in the UK, providing the budget to enable them to continue the project through the hire of Thammasat University researchers, as well as support for student development including study abroad. The research results resulted in policy reforms and practices in cooperation with civil society organizations (CSOs) in Thailand, development of the childcare system, and led to the development of a sustainable childcare system by the Department of Children and Youth (DCY) of the Ministry of Social Development and Human Security (DSDHS). This case study shows the importance of social science research in making a positive impact on the development of the country.

Research Pillar

The Newton Fund, under the Research pillar component, offers research funding from both Thai and UK funding agencies on a matching fund basis, with research on key topics including rice, infectious diseases, swine and poultry, and NCDs, as well as research on specific areas such as astronomy and synchrotron science. The research is a joint project between agencies/universities in Thailand and agencies/universities in the UK. In some cases, joint research projects under the Research pillar may receive Mobility Grants under the People pillar as well. Some projects have resulted in the establishment of Thailand's first advanced science and technology laboratory. Projects in the Research pillar can also be extended to other Pillar programs, such as Institutional Links under the Translational pillar, and also open up opportunities for collaboration with fellow researchers in countries other than the UK.

The main challenge faced has been the COVID-19 situation, which caused UK project participants to stop research in order to focus on COVID-19, with the result that projects could not be completed as agreed. Also, delays occurred owing to the need to seek official approval as the research involved human subjects; since funding sources in the UK are not flexible, this meant that adjustments had to be made to the projects. Further, some projects that required plant samples to be sent from Thailand needed to obtain permission from the UK Government, which took over a year. As a result, funding for some projects was delayed, and in some cases received more than 6 months after signing the contract. On the Thai side, reporting of results requires that a report be submitted every 6 months, while the UK side does not have such a requirement, and the system needs only a short report on the work performed.

Focus group participants made several suggestions for the next phase of the project, which included organisation of a workshop before the announcement of applications to enable researchers to get to know one other before conducting joint projects. Joint research shouldn't focus only on research, but personnel should be developed at the same time. The programmes under each pillar must work together, and in the management of research funding there should be an experienced and competent agency that undertakes responsibility for Thai and UK cooperation in the next phase. The amounts of matching funds should be equal for both parties. In addition, the research projects under the Newton Fund should be expanded into Translational Research and identify private sector partners to undertake technology transfer in order to achieve maximum impact. For this, the Newton Impact Scheme can be used, with inclusion of the private sector and establishment of a new programme or pillar. Reporting on results may not need to be too frequent; it may be appropriate to report only once a year and both sides should report their progress using the same system and be able to view each other's performance. For the next phase, focus group participants proposed research topics for cooperation such as infectious disease, and climate change.

Case Study: Multilateral rice research for resilience

Rice research is one of the four main research topics supported through the Newton Fund: Research Pillar. The National Science and Technology Development Agency (NSTDA) is a delivery partner together with the Biotechnology and Biological Sciences Research Council (BBSRC). Three projects were selected and funded, with the research theme of dealing with climate change. In selection of this research theme, even though the UK is not a commercial rice-growing country, it has expertise in this field that can be applied to important economic crops of the UK such as wheat.

All 3 research projects were led by research teams from Kasetsart University, the Rice Department and NSTDA as the main implementers in Thailand. They worked with the University of Sheffield, Rothamsted Research Computational and Systems Biology and the University of Nottingham on the UK side. The project had a duration of 3 years, and the research focus was on drought-resistant rice varieties and climate change, high productivity, and development of a rice disease outbreak model. All three studies were successfully implemented with satisfactory results and are ready to be developed in the next phase.

The success factor in this work was that researchers had good collaborators and were able to support each other, including the use of advanced technology and suitable infrastructure. The Thai and UK researchers already knew each other and trusted one other. Even though there were problems with regulations for the delivery of rice samples for analysis, and delays in obtaining the budget, which resulted in the inability to close the project at the same time, both teams of researchers collaborated well to solve these problems and were able to work until they achieved success. In addition to the researchers from both countries having a good relationship with each other, the delivery partner agencies on both sides worked together efficiently and professionally and supported the successful completion of the research. The development of rice research differs from other fields, in that the work is carried out as part of a multilateral network with other countries in Asia, namely Thailand, Vietnam, the Philippines and China, together with the UK. This has the advantage of greatly expanding the extent of the rice research network, which may serve as a guideline for implementation of the next phase of the UK-Thailand cooperation.

Case Study: Complementary relationship in Astronomy research

In the implementation of activities under the Research pillar of the Newton Fund, research was supported on the specific field of astronomy. This involved specialized technological cooperation between the UK and Thailand, with, on the Thai side, the National Astronomical Research Institute of Thailand (NARIT), acting as a delivery partner and researcher and, on the UK side, the Science and Technology Facilities Council (STFC) as a delivery partner. The collaboration started with a workshop to create connections between researchers and a total of 3 calls for proposals. A committee was formed with representatives from both sides to select projects. Work was carried out on a matching fund basis. All projects supported were very successful and the project has been further developed into an important astronomical device and instrument for the country. The strong astronomy research network developed between the UK and Thailand has been maintained until the present, with an exchange of researchers every year. NARIT allows UK researchers to work in NARIT laboratories. The uniqueness of this project is that it is a win-win collaboration, focusing on joint development, not just technology transfer from the UK to Thailand, because the profile of each side's technological strengths is different.

Translation Pillar

In the Translation pillar, there were 3 programmes, including Leaders in Innovation Fellowships (LIF), Industry-Academia Partnership (IAP) and Transforming Systems through Partnership (TSP).

The LIF Programme was established by the Royal Academy of Engineering in association with two Thai delivery partners: Thailand Science Research and Innovation (previously known as the Thailand Research Fund); and the National Science and Technology Development Agency. The aim of the programme is to enable and enhance the implementation of research findings in the economy. The two delivery partners completed three core objectives: recruitment of select researchers and entrepreneurs to market the findings; training of business and innovation management through workshops and seminars; and pitching research findings domestically in Thailand and the UK. Moreover, the seminar's attendees received coaching from UK mentors. To date there have been eight seminars, with 110 participants, and LIF alumni maintain a strong network where they exchange knowledge and products. Before attending the training course in the UK, the delivery partner in Thailand organised initial training sessions to provide a foundation to all attendees. The LIF Programme has provided training for researchers and entrepreneurs to be innovative entrepreneurs. Some entrepreneurs were able to commercialise their research results successfully.

Most attendees agreed that it was a good training course, and the programme was something that was new to Thailand and very successful. The major challenge encountered was that most researchers did not leave their academic lives to become entrepreneurs, although they admitted that they changed their attitudes to be more commercial in their research process. Some attendees in the programme's coaching session still keep in touch with their coaches, helping them to create business strategies. Some attendees recommended that the programme should create more opportunities to produce additional benefits. This could be done, for example, by organising sessions to build networks between Thai entrepreneurs and those from other countries, or by attending the same exhibitions, in order to create opportunities for trading between them. Moreover, some entrepreneurs expected to raise funds after finishing training, and they suggested that, in the next phase, the programme should bring angel investors or venture capitalists to meet attendees. All attendees surveyed recommended that the UK Government continue with this programme, although it might have separate streams for entrepreneurs and researchers, because their focuses are different. Also, training in Thailand should be aligned and complemented with training in UK to avoid redundant content.

The IAP Programme, or later TSP Programme, was aimed to link Thailand's researchers, industry and UK researchers, in order to promote technology and knowledge transfer through matching grants between the PMU C, Thailand, and the Royal Academy of Engineering, UK. In this programme, activities and topics were freely initiated from Thai grantees to respond to academic and industrial needs. Apart from research activities to transfer knowledge and technology, grantees could also organise workshops, attend conferences, exchange students and organise short courses. All grantees interviewed stated that they and their industry partners received benefits from this programme. Papers from research could be published in the first-tier journals because there was contribution from industry, and industry partners could use the transferred knowledge and technology in their production processes, creating economic impacts. From this programme, some grantees were able to access networks in Europe. However, a challenge of the programme was that the PMU C and the Royal Academy of Engineering did not align well; their criteria for selection of proposals differ, and the programme would function better if they could be synchronised. All grantees interviewed recommended that the UK Government continue this programme into the next phase, and open topics and activities, like the IAP and TSP Programmes did in the past.

In addition, there is an opportunity to share knowledge between attendees and grantees in the Translation pillar because some attendees from the LIF would like to access funding from IAP or TSP. If they know the criteria and how to write proposals, there would be more opportunities for them to expand their knowledge base from technology transfer. In addition, most attendees and grantees suggested that the UK embassy and Thai delivery partners should build a community of Newton Fund grantees to share knowledge and link their research results and businesses together.

Case Study: LIF programme for uplifting entrepreneurial skills

A notable case study is MACO. MACO is a brand of organic immunity boosters for animals and plants that can substitute for chemical alternatives and help lessen chemical residues in animals and plants. The founder of MACO attended the first training programme and was coached by scholars from Oxford and Cambridge University. After completing their training, they replanned their business and marketing strategies, which appealed to investors. They were able to raise funding of 100 million Thai Baht, which was enough to set up a company and commence the manufacturing of their product, while also branching into two related companies: Green Innovative Biotechnology and Morina Solutions. The innovations created by these two companies won seven awards from various research and innovation contests domestically and internationally. The founder of MACO pointed out that the LIF Programme is beneficial to entrepreneurs by helping them create higher-value products and services that make selling and fundraising more efficient. From the founder's perspective, the challenges he faced while participating in the programme were language and time constraints, which almost resulted in them losing their trip due to visa delays. From the perspective of the UK delivery partners, this programme has some benefits. After completion of the programme, 15 country partners will contribute to the LIF alumni by enabling them to reach TRL Level 7, which would make them eligible to apply for LIF Advance. The grantees of LIF Advance are not only able to reside in the UK but are also able to operate a business there for a total of 5 years. In addition, in some circumstances, they can get funded by venture capital.

The UK delivery partners also shared their insights into the reasons why the research output couldn't be implemented in the real market. They proposed the idea that researchers wouldn't want to become entrepreneurs themselves because they would rather be researchers. Intellectual property rights mostly belong to the researchers' universities. Thus, if entrepreneurs wanted to purchase certain intellectual property rights, that would lead to higher overall costs. In the future, if there is a programme similar to the LIF Programme, separate seminar streams should be organised for the private and public sectors. As of 2023, both delivery partners from Thailand and the UK are still in the process of discussing funding institutions. Currently, in the view of programme participants in Thailand, instead of having an unofficial group (LIF Alumni), there should be a rigid group, similar to an association, to promote more activities to pool resources, build connections, and coordinate with the world's Top 10 universities. This would increase brand awareness and thus increase the sale of the products globally. Lastly, to promote business innovation in Thailand, it is vital to build capacity and coach both CEOs and CFOs exclusively for technological innovations, which would ultimately improve job recruitment.

Global Challenges Research Fund (GCRF)

Many research topics funded under the GCRF related to network building for disease control and vaccine development in low- and middle-income countries. Other topics involved themes such as sustainability of lives, communities and resources, resilience on environmental shocks, inclusiveness, and inequality reduction. UK fund recipients were mostly universities that had conducted the projects in collaboration with partners in Thailand such as Mahidol University, the Mahidol-Oxford Tropical Medicine Research Unit, BIOTEC (NSTDA) and AIT. Contributions of Thai partners included co-funding of the projects, sharing and using their expertise in developing of the vaccines, providing capacity-building, providing pump-priming collaborations in research, and carrying out field surveys and data collection to support the projects. Many of the projects also utilised Thai partners' networks and consortia to assist the projects along the value chain to the end users. For example, NSTDA's BIOTEC not only used its core competencies in designing of vaccines, but also collaborated with its network to work with regulatory agencies to ensure the scaling up of candidate vaccine production and speeding up the process of regulatory approval. Mahidol University and AIT used their expertise in co-

conducting projects, as well as hosting, exchanging and sponsoring secondment for PhD students, which, as one result, has helped in promoting research and scientists' career paths for Thailand.

GCRF fund recipients all agreed that GCRF was a very successful scheme in terms of creating long-term research partnerships between UK and Thailand. Positive feedback was mentioned, including development of their researchers, good relationships and networks gained. In addition, during the GCRF focus group conducted in May 2023, most of participants wanted to see the fund continued, either in the form of GCRF or other similar standardised grants. Moreover, some interview results showed that UK fund recipients see Thai researchers as their preferred partners in the future. From the past experiences of fund recipients, shared in the focus group's brain storming session, many lessons were drawn. First, the future funds/grant scheme should be aimed at 'excellence' in science and technology of the UK and Thailand. Any results from research collaborations should be able to be translated to 'impact' benefiting both countries. Such impact can be achieved through commercialisation or development of policy recommendations, which lead to decision making by policy makers. Importance should be placed on technology transfer, as the process can transform research results into affordable solutions that can benefit many people. One of the examples was knowledge transfer from technology developed in Thailand back to UK, which has produced outcomes in terms of initiatives for the UK and other developing countries in applying Solar Septic Tank technology. Other outcomes that many of the focus group participants agreed upon are networking, long-term research relationships, creating multidisciplinary research teams, as well as knowledge exchange. These will lead to good science in both countries. The focus group participants also suggested topics for future research collaboration, which they felt should consider mutual needs, topics of interest and policy makers'/funders' expectations, as well as strong research areas of both countries. Many participants pointed out that future funding should not specify topics that are too-focused. Instead, defining common themes is more useful, as they help provide guidelines, with themes such as food security and sustainability, climate change and its effect, water system, suggested. These themes also respond to the SDGs as they will build resilience to future shocks (in particular water, food, and climate). GCRF recipients also mentioned what they felt were the key factors for the fund's success from past experiences: success was not limited only to strength in science, but also the opportunity to be introduced to experts in their fields of interest, which many past recipients thought was equally important, as it helps them get to know 'who' their potential target partners should be.

Some useful recommendations from this group were made to improve future implementation of funds/grants for any UK-Thailand collaborations, including: (1) the funder should facilitate a mentoring system for new generations of fund recipients with mechanisms in place such as introduction to experts, language and working culture of both countries; (2) funds/grants could be designed with more flexibility regarding how the grants can be spent. Some part of the budget should be allocated to travel, since most past recipients see development of face-to-face relationships as a very crucial factor in creating successful partnerships. Spending between categories should be allowed; and (3) some additional types of support should be in place, in addition to the normal mechanism. These include mentoring collaborations for the younger generation of researchers, to accelerate learning curves for cross-border collaborations, an impact evaluation process at the end of the projects with key expectations informed priorly to the fund recipients, and project management support for some complex projects, especially those with many partners.

Case study: From mutual interest to mutual benefit – practical wastewater treatment system

Researchers from the University of Glasgow with expertise in microbial communities in wastewater treatment systems collaborated with researchers in Environmental Engineering from the Asian Institute of Technology (AIT), which has expertise in wastewater treatment systems, to receive GCRF funding in 2017-2021 to implement the project “Optimizing decentralized low-cost wastewater infrastructure by managing the microbes”. This project integrated seamlessly the expertise of the two teams of researchers. A postdoctoral Ph.D. student from Thailand went to the University of Glasgow, and an expert from Glasgow came to Thailand to organize training and help establish a new specialized wastewater treatment lab at AIT. A paper was published, which was highly cited, as it combines high-tech research with practical solutions. Implementation of this very successful project produced research results that have the potential to be applied further. It led to the idea of doing decentralized wastewater treatment in a remote area of Scotland, as the system had never been previously used in the UK. The technology from AIT is being adapted for use in the UK to make a pilot decentralized wastewater treatment system. The research team from the University of Glasgow has received funding for 10 years from the UK government to continue development of this work.

This case study demonstrates how the synergies between different areas of expertise can create useful research on the environment, as well as taking wastewater treatment systems that are available in Thailand to undergo trials in suitable areas in the UK. It shows that the UK-Thailand cooperation has mutual benefits, not benefiting only one side.

Case study: From long-lasting relationship to joint research center

Senior researchers from the National Center for Genetic Engineering and Biotechnology (BIOTEC), Thailand, have a strong network with the Professor of Food Safety and founder of the Institute for Global Food Security at Queen's University Belfast, UK. They received GCRF networking grants to carry out research on food safety that focuses on developing tools to reduce the risk of mycotoxins caused by climate change. They aim to build international cooperation through the use of interdisciplinary expertise with 3 groups: 1) experts from the FoodSAFER project, which is funded by the European Union; 2) Mycotox-I of UK-Ireland (a group of experts in the field of assessment and reduction of the risks from contact with mycotoxins along the food chain from crop planting to the consumer); and 3) the International Joint Research Center for Food Security (IJC-FOODSEC), a trilateral collaboration between Queen's University Belfast (QUB), Thammasat University, and NSTDA, to create academic and technological cooperation on this issue for young scientists from low to middle income countries in the ASEAN region as well as relevant stakeholders.

The project will lead to a larger consortium and high-quality proposals to be submitted to various funding agencies when available. There are plans to establish a UK-Thailand joint research unit in Thailand to strengthen research on food security. The research teams of BIOTEC and QUB initiated their collaboration through meeting at an international academic conference in 2009. Subsequently, research cooperation, human development through staff exchange, a student programme, and training activities were mechanisms to sustain their long-term collaboration. Activities included cooperation in funding requests overseas, such as the Marie Curie Fellowship. Most recently, the team has secured funding through RISE programme under a project titled "mycoBEANS" (500,000 Euro for 4 years). The research teams from both countries have published numerous high-quality research papers based on the results of their joint research. As well, a senior researcher from BIOTEC was appointed as an Honorary Professor at QUB, demonstrating the success in building a research network and the potential of a research team that has been able to maintain a long relationship of 14 years duration.

CHAPTER 5 STRATEGIES AND POLICY RECOMMENDATIONS

Data gathered from literature reviews, online surveys, in-depth interviews and focus groups. were analysed to form the basis for development of strategies and policy recommendations for the next phase of the UK-Thailand collaboration in SRI. This data was used to formulate three categories of recommendations: 1) suggested topics for the next phase of collaboration; 2) models for funding mechanisms; and 3) guidelines for management. After that, these draft recommendations were presented at a co-creation workshop meeting attended by stakeholders from both Thai and UK sides representing various groups, including universities, research institutes, government agencies, the private sector, and funding agencies, to discuss the findings and establish strategies and policy recommendations. A total of seventy stakeholders participated in the co-creation workshop, both onsite and online, with the results summarised from the workshop as follows:

1). Suggested topics for the next phase of collaboration

Analysis of the data collected through the various methodologies used in this research identified many proposed topics for implementation. These are illustrated in Figure 5.1, where the font size indicates the frequency of proposals for each topic. Thus, the larger the font size, the higher the frequency the topic was suggested. The research team then presented the above information in the co-creation workshop, where the suggested topics were discussed, and each was given a rating by participants. The seven topics achieving the highest scores were, in order of rating: **1) climate change; 2) infectious diseases & NCDs; 3) agriculture & food security; 4) AI; 5) genomics; 6) circular economy; and 7) synthetic biology.** Examples of related fields under suggested topics are shown in table 5.1.

Table 5.1 Examples of related fields under suggested topics

Key Topics	Examples
1) Climate change	Mitigation and adaptation, Irrigation system and water treatment, Clean and low carbon energy, EV and modern logistics, Biodiversity, natural resource conservation and utilisation, Crisis and natural disasters, Air pollution
2) Infectious diseases & NCDs	Dengue and other tropical diseases, Cancer, Healthy aging, Cardiovascular, Pandemic preparedness
3) Agriculture & food security	Agriculture adaptation, Crop modeling for precision farming, Sustainable agriculture, Alternative foods/ proteins, Food loss/ food waste management, Resilient agriculture
4) AI	AI for tourism and creative economy, Smart city, Smart factory and manufacturing, Smart electronics, robotics and automation, AI in health and social care
5) Genomics	Genomics and medical services, Genomic database, Genetic diseases, Personalised biotherapies
6) Circular economy	Waste management and reduction, Waste utilisation, Carbon capture and recycling
7) Synthetic biology	Bio-based products, High-value compounds, Biodegradable materials, Vaccine and drug development

Taking these research topics together with the policies and priorities of the two countries, as summarised in Chapter 2 of this report, it was found that the topics of climate change, food security, AI, and synthetic/engineering biology matched the established priorities for both the UK and Thailand, while analysis of the SRI capability using the SciVal database (2012-2021) found that the field of infectious diseases was the area of greatest strength among researchers of both countries and is the research

Model 1 proposes a matching fund (details are shown in Figure 5.2) taking, on the UK side, the research system landscape that was adjusted in 2018 to establish the UK Research and Innovation (UKRI) under which there are 9 research councils, and matching this with Thailand's adjusted research system, which in 2019 established the Thailand Science Research and Innovation (TSRI) and 9 Programme Management Units (PMU), by pairing the interests and expertise of the funding agencies of both countries. In this model, the funding agencies and delivery partners are separated from each other because both countries have clearly defined funding agencies under UKRI and TSRI. Therefore, the roles and responsibilities of these agencies are defined by their status as budget holders, while the delivery partners may be agencies that provide budgets themselves, or they could be other agencies that have the capacity to implement successfully, for example, agencies under the Ministry of Higher Education, Science, Research and Innovation (MHESI) or other agencies that have previously worked in the first phase of the UK-Thailand collaboration. Budget for implementation could be provided by the funding agency or other sources. Consideration could be given to joining with other funding agencies in the UK or Thailand that are not under UKRI or TSRI. Three funding schemes were suggested, which are similar to the original Newton Fund scheme, but with the following adjustments:

- Research (fundamental) focuses on supporting research with low TRL but with high potential impact, according to the topics that have been agreed between the two parties, taking into account the policies, urgency, and priorities of both countries, as well as considering the SRI capability of researchers. In this regard, the research should focus on the creation of mutual benefit, which comes from the mutual interests of both parties;
- People Development focuses on programmes that develop people the level of students and mid-career researchers, to senior researchers in different support formats, including support for personnel exchanges, travel budget, bench fee budget for students traveling abroad to do research, funding for organisation of workshops that will build connections between researchers and agencies in the two countries. Research topics should be open, especially in the field social science, which should be strongly supported under this scheme;
- Translation. Work under this component should be adjusted to expand research that has already been carried out under the Newton Fund. It should continue work initiated under the Newton Fund Impact Scheme, which has been very successful in the past. Little of the needed action has been taken in regard to adjusting it to attract greater engagement with, and participation of, the private sector and increase opportunities for research utilisation or commercialisation. In addition, there should be a mechanism to attract investors to participate in order to increase the opportunities for research investment to be used for real benefit.

Model 2 involves use of a block grant format to administer large budget amounts provided by the UK Government, in the same way as the GCRF supports projects on specific or urgent topics. These projects should be jointly implemented by researchers from the UK and Thailand. Examples of research topics are Sustainable Development Goals (SDGs), disasters or pandemics (details are shown in Figure 5.3).

Following the discussions in the co-creation workshop, the majority of participants recommended both funding models, due to the fact that they have different advantages and disadvantages, with a choice made according to the research topics that requested support. A multilateral approach was also proposed at the meeting to expand cooperation with other countries, such as the UK-ASEAN cooperation.

Model 1: Matching Fund

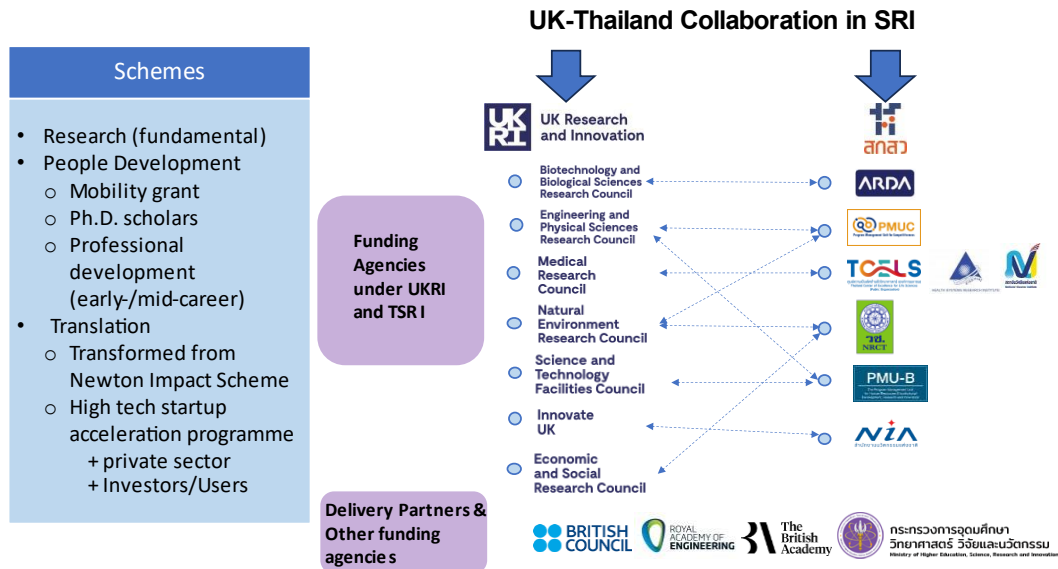


Figure 5.2 Model 1: The matching fund funding mechanism model

Model 2: Block Grant

Large research grant from UK for specific topics

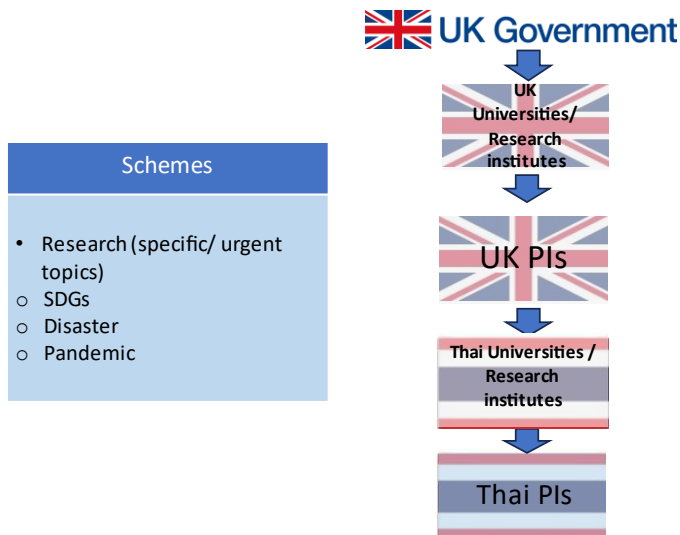


Figure 5.3 Model 2: The block grant funding mechanism model

3) Guidelines for management and other recommendations

- **Build a network** of previous UK-Thailand scholarship recipients/grantees to enable them to get to know each other and further expand partnerships in the future, including organising meetings and workshops to make the network created sustainable;
- **Social science work** should be included to help promote and guide SRI research development and utilisation of SRI results (user requirements, local context, social limitations in SRI use), since quite often the results of fundamental science work cannot be utilised due to a lack of this information;
- There should be **provision for young researchers** to be included in large-scale SRI projects in order to create a researcher network, enhance the capabilities of researchers and create opportunities for the growth of young researchers;
- The management of **intellectual property** created by research projects should be clearly agreed upon and guidelines should be in place to inform implementation;
- Evaluation and project progress **reporting systems** are different in the two countries. Adjustment should be considered in order to make them appropriate. The UK reporting system of reporting only once a year could be used, or, if it is necessary to report every 6 months, as in the Thai system, then the reports should be short and concise in order to reduce the workload of researchers.

APPENDIX I LIST OF LITERATURE REVIEWED

UK policy documents

- UK Research and Development Roadmap 2020
- UK Innovation Strategy 2021
- UK Science and Technology Framework 2023
- Strengthening the UK's Position as a Global Science and Technology Superpower (CST) 2021
- Independent Review of the UK's Research, Development and Innovation: Organisational Landscape 2023
- UKRI Strategy 2022–2027
- UKRI International Strategic Framework 2022
- Science and innovation policy for hard times: an overview of the UK's Research and Development landscape (2022)
- Royal Academy of Engineering Strategy 2020–2025
- National Space Strategy 2021
- Met Office Research and Innovation Strategy 2022
- International Development Strategy (2022)
- International Tech Strategy (2023)
- Integrated Review Refresh (2023)

Thailand policy documents

- Thailand's National Strategy 2018 – 2037
- The Master Plans under the National Strategy (23 plans)
- The Country Reform Plans (13 topics)
- The 13th National Economic and Social Development Plan (2023-2027)
- The National Security Policy and Plan
- The 2021-2027 BCG Action Plan
- Research and Innovation Strategy (2017-2036)
- The Higher Education, Science, Research and Innovation Policy and Strategy (2020-2027)
- Agriculture and Cooperatives Strategic Plan ((2017-2036)
- The Science, Research and Innovation Action Plan (2023-2027)
- Ministry of Higher Education, Science, Research and Innovation 5 Year Action Plan (2023-2027)
- Ministry of Industry 5 Year Action Plan (2023-2027)

APPENDIX II SciVal ANALYSIS

Topic Cluster Top 10 by number of publications (2012-2021)

Ranking	Thailand's Topic Cluster	Publication	FWCI	Prominence percentile	UK's Topic Cluster	Publication	FWCI	Prominence percentile
1	Photocatalysis; Photocatalysts; Solar Cells	2,158	1.27	99.866	Galaxies; Stars; Planets	27,245	1.83	97.860
2	Malaria; Plasmodium Falciparum; Parasites	1,660	1.85	84.415	Industry; Innovation; Entrepreneurship	16,092	1.90	98.997
3	Dengue; Viruses; Dengue Virus	1,621	1.31	91.572	Algorithms; Computer Vision; Models	15,967	2.97	99.799
4	Algorithms; Computer Vision; Models	1,609	0.86	99.799	Attention; Brain; Learning	14,279	1.32	95.987
5	HIV; HIV Infections; HIV-1	1,522	1.24	94.515	Obesity; Motor Activity; Child	14,036	2.01	98.662
6	Polypropylenes; Lactic Acid; Blending	1,472	1.04	96.722	COVID-19; SARS-CoV-2; Coronavirus	12,201	6.39	100
7	Fixed Point; Fixed Point Theorem; Metric Space	1,445	1.07	68.294	Students; Medical Students; Education	10,884	1.13	95.251
8	Decay; Quarks; Neutrinos	1,343	3.61	96.321	Monetary Policy; Economic Growth; Exports	10,757	1.33	94.716
9	Catalysts; Zeolites; Hydrogenation	1,227	0.99	99.398	Alzheimer Disease; Dementia; Amyloid	10,751	2.09	97.926
10	Industry; Research; Marketing	1,174	0.92	99.130	Cognitive Radio; MIMO Systems; Orthogonal Frequency Division Multiplexing	10,634	2.15	96.990

Source: NSTDA (SciVal analysis tool), 2023

Institution Top 10 by number of publications (2012 - 2021)

Ranking	Thailand's Institution	Publication	FWCI	UK's Institution	Publication	FWCI
1	Mahidol University	28,047	1.16	University College London	168,056	2.16
2	Chulalongkorn University	26,159	1.10	University of Oxford	153,921	2.34
3	Chiang Mai University	16,496	0.99	Imperial College London	130,299	2.22
4	Khon Kaen University	13,281	0.80	University of Cambridge	124,492	2.16
5	Kasetsart University	13,160	0.88	King's College London	107,676	2.19
6	Prince of Songkla University	11,372	0.91	University of Manchester	91,658	1.89
7	Thammasat University	8,407	0.83	University of Edinburgh	81,301	2.22
8	King Mongkut's Institute of Technology Ladkrabang	8,229	0.67	University of Nottingham	63,281	1.80
9	National Science and Technology Development Agency	7,606	1.00	University of Bristol	59,788	2.20
10	King Mongkut's University of Technology Thonburi	7,534	1.10	University of Southampton	58,789	1.99

Source: NSTDA (SciVal analysis tool), 2023

Topic Cluster Top 10 of 10 Years' Co-publications (2012 – 2021)

Ranking	Topic Cluster	Co-Publication	Prominence Percentile	FWCI
1	Decay, Quarks, Neutrinos	1,189	96.321	237.66
2	Malaria, Plasmodium Falciparum, Parasites	741	84.415	132.66
3	Dengue, Viruses, Dengue Virus	174	91.572	34.32
4	HIV, HIV Infections, HIV-1	171	94.515	197.80
5	Cystic Fibrosis, Cystic Fibrosis Transmembrane Conductance Regulator, Pseudomonas aeruginosa	157	61.003	29.49
6	Galaxies, Stars, Planets	152	97.860	17.73
7	Anti-Bacterial Agents, Infection, Methicillin-Resistant Staphylococcus Aureus	148	97.057	26.50
8	COVID-19, SARS-CoV-2, Coronavirus	114	100	249.04
9	Human Influenza, Orthomyxoviridae, Influenza Vaccines	114	96.589	82.97
10	Echinococcosis, Schistosomiasis, Parasites	103	76.187	20.31

Source: NSTDA (SciVal analysis tool), 2023

Top 10 Institutes of 10 Years' Co-publications (2012 – 2021)

Ranking	Thailand's Institute	Co-Publication	FWCI	UK's Institute	Co-Publication	FWCI
1	Mahidol University	3,534	1.76	University of Oxford	19,129	3.50
2	Chulalongkorn University	3,437	1.34	University College London	16,698	2.71
3	Chiang Mai University	1,817	1.28	University of Cambridge	14,844	3.67
4	Kasetsart University	1,310	0.85	Imperial College London	12,053	3.00
5	National Science and Technology Development Agency Thailand	944	1.17	University of Manchester	9,300	2.36
6	King Mongkut's University of Technology Thonburi	942	1.11	University of Edinburgh	7,821	3.98
7	King Mongkut's Institute of Technology Ladkrabang	914	0.67	King's College London	6,207	3.42
8	Prince of Songkla University	856	0.97	London School of Hygiene and Tropical Medicine	6,161	4.21
9	Khon Kaen University	685	0.99	University of Liverpool	4,365	3.23
10	Thammasat University	675	0.94	University of Birmingham	3,815	3.53

Source: NSTDA (SciVal analysis tool), 2023

SciVal global ranking by topics (2013-2022)

Topic	UK's ranking	Thailand's ranking
Agri and Bioscience	4	23
Computer science	5	27
Environmental science	4	27
Medicine	3	27
Veterinary	3	16
Immunology and Microbiology	3	20
Earth and Planetary science	3	28
Biochemistry and Genetics	4	26
Pharmacology, Toxicology and Pharmaceuticals	4	22
Physics and Astronomy	7	26
Health professional	2	19
Energy	5	26
Social science	2	28
Chemical engineering	7	23
Chemistry	6	25
Decision science	4	24

Source: NSTDA (SciVal analysis tool), 2023

APPENDIX III LIST OF INTERVIEWEES

No.	Position	Organisation	Pillar/Programme
Delivery partners/Funding Agencies			
1	Vice President/ Assistant to the President	Thailand Science Research and Innovation (TSRI)	Translation Pillar: LIF, Institutional Link /Research Pillar: Infectious disease
2	Vice President/ Division Director	Office of National Higher Education Science Research and Innovation Policy Council (NXPO)	Translation Pillar: Institutional Link
3	Executive Director	National Astronomical Research Institute of Thailand (NARIT)	Research Pillar
4	Researchers	Synchrotron Light Research Institute (SLRI)	People and Translation Pillar
5	Directors	National Research Council of Thailand (NRCT)	Translation Pillar: Institutional Link, Impact Scheme
6	Project Coordinator	The Institute for the Promotion of Teaching Science and Technology (IPST)	People Pillar: STEM Ambassador
7	Project Coordinator	The Institute for the Promotion of Teaching Science and Technology (IPST)	People Pillar: STEM Assessment
8	Division Director	Ministry of Higher Education, Science, Research and Innovation (MHESI)	People Pillar: Mobility Grant/ Translation Pillar: IAPO and TSP
9	Former Vice President/ Assistant Executive Director/	National Science and Technology Development Agency (NSTDA)	Research Pillar: Rice, Infectious diseases
10	Project Analysts	National Science and Technology Development Agency (NSTDA)	Research Pillar: Rice
11	Project Analysts	National Science and Technology Development Agency (NSTDA)	Research Pillar: Infectious diseases
12	Project Coordinators	National Science and Technology Development Agency (NSTDA)	Translational Pillar: LIF
13	Project Coordinators	Royal Academy of Engineering	Translational Pillar: LIF
14	Head of International Education Services/ Project Coordinator	British Council	People Pillar: Researcher Link, Ph.D. Programme/ Translational Pillar: Institutional Link
15	Head of International Partnership/Former Project Coordinator	UK Research and Innovation (UKRI)/ BBSRC	Research Pillar: Rice, Swine & Poultry
16	Deputy Director	Program Management Unit for Human Resources & Institutional Development, Research and Innovation (PMU B)	
17	Deputy Director	Program Management Unit For Competitiveness (PMU C)	
18	Executive Director	Health Systems Research Institute (HSRI)	
19	Executive Director	National Innovation Agency (NIA)	
20	Executive Director	National Vaccine Institute (NVI)	

No.	Position	Organisation	Pillar/Programme
21	Deputy CEO	Thailand Center of Excellence for Life Sciences (Public Organisation) (TCELS)	
Grantees			
22	Entrepreneur	Private companies	Translation Pillar: LIF
23	Researcher	Mahidol University	Research Pillar: Infectious diseases
24	Researcher	Mahidol University	Research Pillar: Infectious diseases
25	Researcher	Mahidol University	Research Pillar: Infectious diseases
26	Researcher	Chiang Mai University	Research Pillar: Infectious diseases
27	Researcher	Kasetsart University	Research Pillar: Rice
28	Researcher	Kasetsart University	Research Pillar: Rice
29	Researcher	Rice Department	Research Pillar: Rice
30	Researcher	Chiang Mai University	Research Pillar: Swine & Poultry
31	Researcher	University of Glasgow	GCRF
32	Researcher	Oxford University	GCRF
33	Researcher	Open University	People Pillar: Research Link for Travel Grant

APPENDIX IV ONLINE SURVEY

Overview of respondents

Category of respondent	Researcher	Funding Agency
Number	171	19

Funding Agency Affiliation Information

Name of Agency	Number
National Research Council of Thailand (NRCT)	3
National Science and Technology Development Agency (NSTDA)	1
Royal Academy of Engineering	3
Synchrotron Light Research Institute	1
Thailand Center of Excellence for Life Sciences (Public Organisation)	1
Thailand Institute of Nuclear Technology (Public Organisation)	1
UKRI	1
Did not provide agency name	8
Total	19

Funding scheme/Funding Agency with previous UK-Thailand cooperation

Funding scheme	Number
Other funding programme (Prosperity Fund)	1
Newton Fund	7
• People (Researcher Links) Pillar	1
• Research Pillar	2
• Translation Pillar	4

Information on Researchers' Affiliation

Name of Agency	Number
ACI Software Co., Ltd.	1
Asia Bio Business	1
Asian Institute of Technology	3
Asian Palm Oil Company Limited	1
Bangkok Expressway and Metro Public Company Limited (Expressway Business)	2
Biotechnology and Biological Sciences Research Council	1
Cambridge University	2
Chiang Mai University, THAILAND	6
Chiangmai Rajabhat University, Thailand	1
Chulalongkorn University, Thailand	14
Chulalongkorn university, Wealthy Moggie Innovation Co., Ltd., ReNew Innovations Co., Ltd.	1
Circularity Co., Ltd.	2

Name of Agency	Number
Crown itech Co., Ltd.	1
Faculty of Dentistry, Srinakarinwirot University	1
FAI GAEM MAI PROJECT	1
GM	1
Heriot Watt University and the Institute of Occupational Medicine	1
IDEA2EXPERT Co., Ltd.	1
Imperial College London	4
Kasetsart University	3
Keele University	1
Khon Kaen University	5
King Mongkut's Institute of Technology Ladkrabang	3
King Mongkut's University of Technology Thonburi	7
Lancaster University	1
Liverpool John Moores University	1
London's Global University	2
Mahasarakham University	2
Mahidol University	15
Manchester Metropolitan University	2
Ministry of Public Health, Thailand	4
Micro MIM JAPAN	2
Ministry of Transport, Thailand	1
MORU	1
Naresuan University	2
National Science and Technology Development Agency (NSTDA)	27
Network Rail	1
Newcastle University	1
NIAB	1
PAC Corporation (Thailand)	1
Payap University	2
Pirbright Institute	2
Prime Nanotechnology Co., Ltd.	2
Prince of Songkla University	1
Quadram Institute Bioscience	1
Royal Academy of Engineering	1
SATARANA	1
SCG Cleanergy	1
Siamnovas Co., Ltd.	1
Silpakorn University	1
SRUC	1
Suranaree University of Technology	1
Synchrotron Light Research Institute (Public organisation)	3
TAISEI KOGYO (THAILAND) Co., Ltd.	1
Thaksin University	3

Name of Agency	Number
Thammasat University	1
The Pirbright Institute	1
UCL School of Pharmacy	1
University College London	2
University of Oxford	1
University of Bath	1
University of Cambridge	1
University of Glasgow	1
University of Kent	2
University of Leicester	1
University of Nottingham	1
University of Portsmouth	1
Did not indicate name of agency	7
Total	171

Funding scheme from which Researcher received support

Funding scheme	Number
Global Challenges Research Fund (GCRF)	10
Newton Fund	51
• People Pillar	15
- Advanced Fellowship	4
- Mobility grant	4
- Professional Development	3
- PhD programmes	1
- Researcher Links	7
• Research Pillar	21
- Infectious diseases	6
- Cancer	1
- Rice	2
- Energy – Food – Water	4
- Atmospheric Pollution & Human Health	2
- Impact of Change on Water Resources	1
- Noncommunicable diseases (NCDs)	2
- Swine and poultry	6
• Translation Pillar	23
- Institutional Links	12
- Leaders in Innovation Fellowship	16
- Industry-Academia Partnerships / TSPP	13
- Newton Fund Impact Scheme	7
Did not indicate name of fund	8
Total	69

APPENDIX V CO-CREATION WORKSHOP

Number of participants in Co-creation workshop

Total	Thailand	UK
74	63	11

List of participant's affiliations

1. Agricultural Research Development Agency (Public Organization)
2. Asian Institute of Technology
3. British Council
4. Chiang Mai University
5. Chulalongkorn University
6. Durham University
7. FCDO
8. Institute for the Promotion of Teaching Science and Technology
9. Kasetsart University
10. Khon Kaen University
11. King Mongkut's University of Technology Thonburi
12. Mahidol University
13. National Astronomical Research Institute of Thailand
14. National Center for Genetic Engineering and Biotechnology
15. National Innovation Agency
16. National Nanotechnology Center
17. National Science and Technology Development Agency
18. Office of National Higher Education Science Research and Innovation Policy Council
19. Office of the Basic Education Commission
20. Open University
21. Pirbright University
22. Private sector
23. Synchrotron Light Research Institute (Public Organization)
24. Thailand Science Research and Innovation
25. Thaksin University
26. UKRI
27. Universities UK International (UUKI)
28. University of Strathclyde

APPENDIX VI PUBLIC DIALOGUE

A dissemination event was held as a public dialogue at Centara Grand at Central Plaza Ladprao Bangkok on 2nd October 2023 to broadcast the facts and results of the project. A total of 77 participants from 40 organisations participated in the event both onsite at the venue and online via Zoom system.



Recommendations from public dialogue

- All the Thai funding agencies including all Program Management Units (PMUs) need to be officially informed of the recommendations obtained from this research project. The best mechanism to ensure that the recommendations will be addressed seriously might be through TSRI and the UK funding agencies.
- While the UK funding agencies are discipline-based, the Thai PMUs are rather different. It is vital to appropriately and correctly match the UK research councils with Thai's PMUs. More concerns were raised on the fact that many PMUs might have to work together to match the corresponding UK council
- The need to provide research funding throughout the value chain from basic science to utilization must be met. For instance, the Thai PMUs does not provide much funding on fundamental research, except only for some specific issues such as infectious disease or genomics, while the Newton fund in the past supported funding different stages of research and development throughout the value chain.
- Many research topics such as Malaria and Dengue require a long-term collaborative unit, which requires long commitment of funding. There should be a mechanism to support and utilise the already-established consortiums to allow expansion to other research collaborations as well.
- Given the early success of the bilateral collaboration, there should be a separate funding set aside for this UK-Thailand collaboration.
- An involvement from social science, arts and humanity is a strong point which should be included in the supporting scheme. Additionally, multidisciplinary, and multicultural research should also be taken into account.
- Mechanism for funding PhD students should cover every area of research.
- To break wall between disciplines, we should collaborate with both academic and non-academic partners and researchers.
- Given the differences in their practices, each PMU might consider working on different schemes otherwise they would need to derive mechanisms to work together seamlessly.
- Funding management in Thailand still needs further development because of the strictness and lack of flexibility of the system.
- Foresight method should be applied to shape the priorities and the area of collaboration for

next phase of UK-Thailand collaboration.

- There should be mentoring organisations/systems that help with the issues mentioned in the project's results.

List of participant's affiliations

1. Agricultural Research Development Agency (Public Organization)
2. British Council
3. Chiang Mai University
4. Cranfield University
5. Department for Science, Innovation and Technology (DSIT)
6. Department of Science Service
7. Dhonburi Rajabhat University
8. Foreign, Commonwealth and Development Office
9. Geo-Informatics and Space Technology Development Agency
10. Hydro Informatics Institute (Public Organization)
11. Kasetsart University
12. King Mongkut's University of Technology Thonburi
13. Mahidol University
14. Nakhon Phanom University
15. National Astronomical Research Institute of Thailand
16. National Center for Genetic Engineering and Biotechnology (BIOTEC)
17. National Electronics and Computer Technology Center (NECTEC)
18. National Innovation Agency
19. National Institute of Metrology
20. National Nanotechnology Center (NANOTEC)
21. National Research Council of Thailand
22. National Science and Technology Development Agency
23. Navamindradhiraj University
24. Office of National Higher Education Science Research and Innovation Policy Council
25. Office of the Permanent Secretary (OPS), MHESI
26. Rice Science Center
27. Royal Academy of Engineering
28. Silpakorn University
29. Sirindhorn International Institute of Technology
30. Surat Thani Rajabhat University
31. Thailand Institute of Nuclear Technology
32. Thailand Institute of Scientific and Technological Research
33. Thailand National Metal and Materials Technology Center (MTEC)
34. Thailand Science Research and Innovation (TSRI)
35. Thammasat University
36. UK Collaborative on Development Research (UKCDR)
37. UK Research and Innovation
38. University of Strathclyde
39. Walailak University
40. Wellcome Trust

APPENDIX VII TEAM

Team members: Role, responsibilities, and expertise of team

Positions & Roles	Relevant areas of expertise	Tasks
Project advisors		
Prof. Duncan Graham (University of Strathclyde, UK)	Chemistry, nanoparticles	Giving advice
Prof. Christopher Elliott, OBE (Queen's University Belfast, UK)	Food system, UK-Thailand collaboration	Giving advice
Dr. Kenisha Garnett (Cranfield University, UK)	Futures analysis, strategic risk assessment, and stakeholder and public engagement	Giving advice
Dr. Chadamas Thuvasethakul (Advisor at NSTDA, Thailand)	Policy research, human resources development in STI	Giving advice
Dr. Uracha Ruktanonchai (NSTDA, Thailand)	Nanoencapsulations, nanotechnology	Giving advice
Project Leader (PI)		
Dr. Pattamaporn Prachomrat Policy researcher at NSTDA, Thailand	Strategy management, national innovation system, policy research	Project lead
Researchers		
Prof. Nitsara Karoonuthaisiri (PhD) Principal Research Fellow at BIOTEC, Thailand, Honorary Professor at QUB	Agriculture and food technology research	Conducting research
Dr. Nucharin Ratchukool Director, Organisation Strategy and Policy Management Division at NSTDA	STI Indicators, policy research	Conducting research
Dr. Thanyaporn Hattasingh Senior Policy Researcher at NSTDA	STI policy and strategy, STI management	Conducting research
Dr. Karantararat Nakwa Senior Policy Researcher at NSTDA	Technology management, policies promoting Thai innovation products	Conducting research
Kanya Sitsanguan Policy researcher at NSTDA, Thailand	Corporate strategic plans, technology roadmap	Conducting research
Simon Grimley Senior Advisor at NSTDA	International STI strategy	Conducting research
Kulwarang Suwanasri Policy researcher at BIOTEC, Thailand	Agricultural and food system policy, Climate change impacts	Conducting research

Positions & Roles	Relevant areas of expertise	Tasks
Sronkanok Tangjaijit International Collaboration Division at NSTDA	International research cooperation	Conducting research
Mullika Kulsiripruck International Collaboration Division at NSTDA	International research cooperation	Conducting research

REFERENCES

- Association of Southeast Asian Nations (2023). Retrieved from <https://asean.org/member-states/>
- British Council Thailand (2023). Newton Fund. Retrieved from <https://www.britishcouncil.or.th/en/newton-fund>.
- Cabinet Office (2023). Integrated Review Refresh 2023: Responding to a more contested and volatile world. Retrieved from <https://www.gov.uk/government/publications/integrated-review-refresh-2023-responding-to-a-more-contested-and-volatile-world/integrated-review-refresh-2023-responding-to-a-more-contested-and-volatile-world>
- Council for Science and Technology (2021). Strengthening The UK's Position as a Global Science and Technology Superpower. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1002894/CST_Global_Britain.pdf
- Department for Science, Innovation and Technology and Department for Business, Energy & Industrial Strategy (2020). Retrieved from <https://gov.uk/government/publications/uk-research-and-development-roadmap>
- Department for Business, Energy and Industrial Strategy (July 2021). UK Innovation Strategy: Leading the future by creating it. Retrieved from <https://www.gov.uk/government/publications/uk-innovation-strategy-leading-the-future-by-creating-it>.
- Department for Business, Energy and Industrial Strategy (2022). The Newton Fund Final Evaluation Report Retrieved from <https://www.gov.uk/government/publications/newton-fund-final-evaluation-and-supporting-evidence>.
- Department for Business, Energy and Industrial Strategy (2023). Independent Review of the UK's Research, Development and Innovation Organisational Landscape. Retrieved from <https://www.gov.uk/government/publications/research-development-and-innovation-organisational-landscape-an-independent-review>.
- Department for Science, Innovation and Technology (2023). The Science and Technology Framework. Retrieved from <https://www.gov.uk/government/publications/uk-science-and-technology-framework>
- Department for Science, Innovation and Technology and Foreign, Commonwealth & Development Office (2023). The UK's International Technology Strategy Policy Paper. Retrieved from <https://www.gov.uk/government/publications/uk-international-technology-strategy/the-uks-international-technology-strategy>.
- Department for Digital, Culture, Media & Sport and Paul Scully MP (2023). UK tech sector retains 1 spot in Europe and 3 in world as sector resilience brings continued growth. Retrieved from <https://www.gov.uk/government/news/uk-tech-sector-retains-1-spot-in-europe-and-3-in-world-as-sector-resilience-brings-continued-growth>.
- Economic and Social Research Council (2022). Science and innovation policy for hard times: an overview of the UK's Research and Development landscape. Retrieved from <https://www.ukri.org/what-we-do/our-main-funds-and-areas-of-support/browse-our-areas-of-investment-and-support/the-economy/productivity/>
- Foreign, Commonwealth & Development Office (2022). The UK government's strategy for international development. Retrieved from <https://www.gov.uk/government/publications/uk-governments-strategy-for-international-development/the-uk-governments-strategy-for-international-development>
- Government Office for Science (2022). Guidance on assessing performance and value of Public Sector Research Establishments. Retrieved from <https://www.gov.uk/government/publications/public-sector-research-establishment-value-framework>.

International Institute for Management Development. IMD World Competitiveness Ranking 2022
Retrieved from <https://www.imd.org/centers/wcc/world-competitiveness-center/rankings/world-competitiveness-ranking/>

Met Office (2022). Research and Innovation Strategy. Retrieved from <https://www.metoffice.gov.uk/research/approach/research-and-innovation-strategy>

Ministry of Agriculture and Cooperatives (2017). The 20-Year Agricultural and Cooperatives Strategy (2017-2036). Retrieved from <https://www.moac.go.th/moaceng-magazine-preview-422991791792>

Ministry of Higher Education Science Research and Innovation (2023). MHESI Open Data. Retrieved from <https://data.mhesi.go.th/>

National Research council of Thailand and National Science Technology and Innovation Policy Office. (2017). Thailand National Research Policy and Strategy (2017-2036). Retrieved from <https://research.kku.ac.th/wp-content/uploads/2022/10/Thailands-20-year-Research-and-innovation-Strategy-2017-2036.pdf>

National Science and Technology Development Agency (2019). Global Alliance. Joint Programs. Newton UK-Thailand Research and Innovation Partnership Fund Retrieved from <https://www.nstda.or.th/en/>

National Science and Technology Development Agency (2021). The 2021-2027 BCG Action Plan. <https://www.bcg.in.th/eng/vision/>

National Strategy Secretariat Office, Office of the National Economic and Social Development Board (2018). Thailand's National Strategy 2018 – 2037. Retrieved from https://www.bic.moe.go.th/images/stories/pdf/National_Strategy_Summary.pdf

Newton Fund, GCRF Global Challenges and Research Fund (2023). Retrieved from <https://www.newton-gcrf.org/newton-fund/>

Nurse, P. (2023). Independent Review of the UK's Research, Development and Innovation Organisational Landscape. Retrieved from: www.gov.uk/government/publications/researchdevelopment-and-innovation-organisational-landscape-an-independent-review

Office of Industrial Economics (2023). Industrial Master Plans (2023-2027). Retrieved from http://www.oie.go.th/view/1/Industrial_Master_Plans/EN-US

Office of National Economic and Social Development Council (2018). The Country Reform Plans. Retrieved from <http://nscr.nesdc.go.th/cr/>

Office of National Economic and Social Development Council (2018). The Master Plans under the National Strategy. Retrieved from <http://nscr.nesdc.go.th/master-plans/>

Office of National Economic and Social Development Council (2023). The Thirteenth National Economic and Social Development Plan (2023-2027). Retrieved from https://www.nesdc.go.th/nesdb_en/download/article/article_20230615134558.pdf

Office of National Higher Education Science Research and Innovation Policy Council (2020). The Higher Education, Science, Research and Innovation Policy and Strategy (2020-2027). Retrieved from <https://www.nxpo.or.th/th/en/higher-education-science-research-and-innovation-policy/>

Office of National Higher Education Science Research and Innovation Policy Council (2022). Higher Education, Science, Research and Innovation Policy. Retrieved from <https://www.nxpo.or.th/th/en/higher-education-science-research-and-innovation-policy/>

Office of National Higher Education Science Research and Innovation Policy Council (2022). The Higher Education, Science, Research and Innovation Policy and Strategy (2023-2027). Retrieved from <https://www.nxpo.or.th/th/en/14299/>

Office of the National Security Council, Office of the Prime Minister (2019). The National Security Policy and Plan (2019 – 2022). Retrieved from <https://www.nsc.go.th/wp-content/uploads/2020/05/The-National-Security-Policy-and-Plan2019-%E2%80%93-2022.pdf>

- R. A. L. Jones (2022). *Science and innovation policy for hard times: an overview of the UK's Research and Development landscape*. Productivity Insights Paper No. 014, The Productivity Institute
- Royal Academy of Engineering (2020). Strategy 2020–2025 Engineering for a sustainable society and inclusive economy. Retrieved from <https://raeng.org.uk/media/bttm3kha/raeng-2020-25-strategy.pdf>
- SciVal. Retrieved from <https://www.scival.com>. Accessed 2023
- Tetra Tech International Development (February 2022). The Newton Fund – Final Evaluation Report Retrieved from <https://www.newton-gcrf.org/wp-content/uploads/2022/02/newton-fund-final-evaluation-report.pdf>
- UK Research and Innovation (2020). Growing research capability to meet the challenges faced by developing countries. Retrieved from <https://www.ukri.org/wp-content/uploads/2020/10/UKRI-22102020-growing-research-capability-to-meet-the-challenges-faced-by-developing-countries.pdf>.
- UK Research and Innovation (2022). UKRI strategy 2022 to 2027. transforming tomorrow together. Retrieved from <https://www.ukri.org/about-us/strategy-plans-and-data/our-strategy-2022-to-2027/>
- UK Research and Innovation (2022). UKRI International Strategic Framework. Retrieved from <https://www.ukri.org/wp-content/uploads/2022/10/UKRI-300922-InternationalStrategicFramework.pdf>
- UK Research and Innovation (2023). Global Challenges Research Fund. Retrieved from <https://www.ukri.org/what-we-offer/international-funding/global-challenges-research-fund>
- UK Space Agency, Department for Science, Innovation and Technology, Ministry of Defence, and Department for Business, Energy & Industrial Strategy (2021). National Space Strategy. Retrieved from <https://www.gov.uk/government/publications/national-space-strategy>
- World Intellectual Property Organization. Global Innovation Index 2022. Retrieved from https://www.wipo.int/global_innovation_index/en/2022/