REPUTATIONAL IMPACTS OF INTERNATIONAL RESEARCH AND INNOVATION

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March 2025

4.2. UK's large-scale infrastructure facilitating international R&I

The UK's large-scale infrastructure is pivotal in facilitating international R&I. The UK government and funding agencies are investing in the establishment of large national and international infrastructure for use by both national and international researchers. This effort is complemented by agreements with other nations for the mutual use of these facilities and broad access to data produced by these infrastructures. Additionally, the UK is establishing hubs, centers, and networks to support technology commercialization, business growth, and investor confidence. Furthermore, there is a strong focus on developing capabilities, supply chains, and strategic technologies to maximize the effective use of these large infrastructures. The UK's reputation as an attractive destination for international research and innovation (R&I) is bolstered by its large-scale infrastructure support. Additionally, the UK is recognized for its competitive advantages in key sectors (where the infrastructure facilities are based), further enhancing its appeal to global researchers and investors. This reputation generates financial, relational, resource, research, and innovation impacts [Figure 4.2].

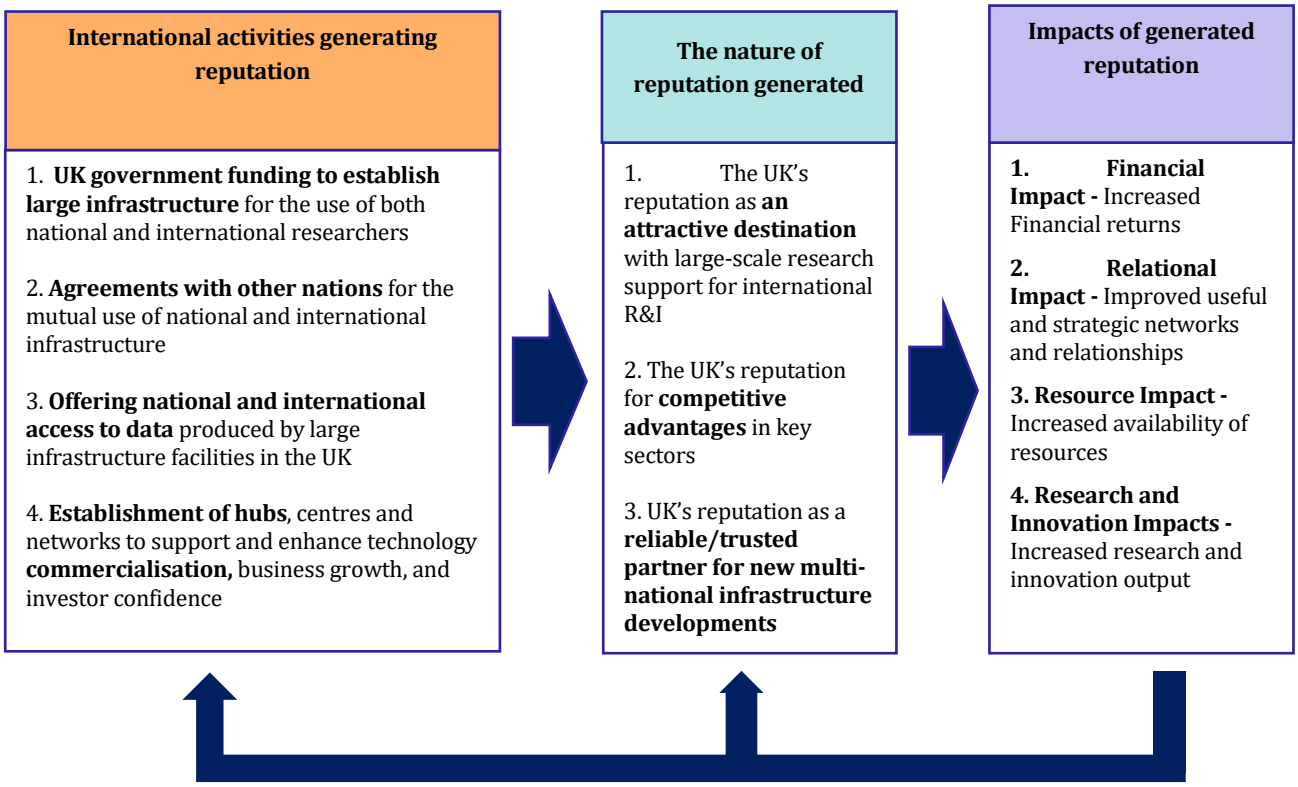

Figure 4.2: UK's large-scale infrastructure facilitating international R&I generating reputational impacts

4.2.1 International activities

UK government funding to establish large infrastructure for the use of both national and international researchers

UK government funding for establishing large-scale infrastructures accessible to researchers worldwide fosters a collaborative, international, and inclusive research environment. Following the announcement of the UK Association to Horizon Europe, the UK has re-joined the European Strategy Forum on Research Infrastructures (ESFRI), facilitating collaboration on the development of research infrastructure regionally and internationally (Science & Technology Framework, 2024). The ISIS Neutron and Muon Source, funded by UK Research and Innovation (UKRI), has been used widely by international researchers.

The UK has been upgrading and expanding its R&D infrastructure, such as the Diamond Light Source, the world's most powerful laser Vulcan 20-20 that enables the UK's world-class R&D base to test ideas, develop new materials and technologies, and make significant scientific discoveries, all of which contribute to achieving the UK's 2030 ambitions and delivering impactful outcomes (Knowledge & Technology Framework, 2024). Other UK research infrastructure

investments include aerospace, life sciences, materials, and energy investments in cyber-physical infrastructure and national research data clouds.

The UK government's investments in large-scale advanced physical and digital infrastructures and computing capabilities such as a supercomputer in Edinburgh and the AI Research Resource (AIRR) in Bristol and Cambridge are other game-changing infrastructure initiatives with £1.5 billion investment package aiming to upgrade the UK's next-generation computing capacity, fuelling growth and transforming the future of UK science and technology. These infrastructure initiatives play a key role in linking UK and international scientists to generate synergies. Such linkages help build the UK's reputation as a destination with attractive, advanced, and up-to-date infrastructure that fosters international R&I linkages.

The UK supports partnerships between domestic research centres and those around the world to enhance scientists' access to cutting-edge facilities. For instance, the ISIS Neutron and Muon source has a number of long-standing agreements with overseas research funders to support their scientists' use of the facility. These not only support collaborations but also generate significant inward investment. For example, the agreement of ISIS Neutron and Muon source with Italy (during 2021-2027) is worth around £10m. Such agreements facilitate the establishment of common standards, promote openness and transparency in research, and support responsible research practices. It has also been reported that the use of ISIS by researchers from India has grown significantly over recent years. The UK Government's Newton funding has led to the use of ISIS by Indian researchers and providing funds for instrument development through a partnership agreement with the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) for the Department of Science and Technology (DST) Nanomission project. This agreement supports Indian scientists' use of ISIS and provides funds for instrument developments (UKRI, 2023).

The evidence suggests that Portuguese researchers use ISIS for a wide range of science including fundamental and applied magnetics systems, photovoltaics, semiconducting materials, cancer-related studies, and other investigations which have led to two recent ISIS Impact Awards won by Portuguese scientists. ISIS as a member also funds members of the League of Advanced European Neutron Sources (LENS).

These collaborative agreements centred around infrastructure clearly make the UK an attractive destination for global researchers to conduct their research with UK researchers. Such partnerships enhance the mutual use of infrastructure between the UK and overseas reinforcing the reputation of the UK's commitment to advancing R&I and fostering international collaborations for this purpose.

Agreements with other nations for the mutual development of international infrastructure

The UK has a strong commitment to international scientific collaboration, investing significantly in multi-national infrastructure projects. For example, the UK is a founding member of CERN, contributing around £160 million annually to support its operations and research, including the Large Hadron Collider (LHC). This collaboration was instrumental in the discovery of the Higgs boson, a fundamental particle that explains why other particles have mass. The theoretical prediction of the Higgs boson by Peter Higgs and François Englert was confirmed by experiments at CERN's LHC, leading to their Nobel Prize in Physics in 2013 (Nobel Prize in Physics 2013).

The UK also plays a crucial role in the European Southern Observatory (ESO), which operates some of the world's most advanced ground-based telescopes1. Additionally, the UK is a key partner in the European X-ray Free Electron Laser (EU-XFEL) in Germany, which generates intense X-ray flashes for cutting-edge research in various scientific fields1. These investments not only advance global scientific knowledge but also enhance the UK's leadership and innovation in science and technology.

Offering national and international access to data

The UK strengthens its position as an active partner in priority international research infrastructure by offering national and international access to data. In some instances, data is produced by its large infrastructure facilities across borders and in other instances the data is produced by other mechanisms associated with gathering data (e.g. Biobank). The UK has enhanced its reputation as a destination for large-scale research support through initiatives like the UK Biobank, large-scale biomedical databases, and research resources for global health researchers, funded by the MRC that provides a vast biomedical database and has facilitated numerous medical breakthroughs. The UK Biobank has users from more than 90 countries and has influenced global advancement in the field of genetics. It has thus positioned the UK as a world leader in the field of genetics. Additionally, by reducing compliance burdens and modernizing regulatory frameworks, the UK ensures that researchers can efficiently utilize large-scale data for impactful studies through the Data Protection and Digital Information (DPDI) Bill reforms. This provides researchers with a clear legal framework for scientific research, streamlining the process of accessing essential data. For instance, these legal frameworks facilitated significant research in clinical and behavioural risk factors for COVID-19 and the long-term impacts of SARS-CoV-2 infection (Biobank UK, 2022). This open access to large-scale data develops the reputation of the UK as a conducive and collaborative research environment, making the UK a desirable destination for researchers worldwide and international R&I as a destination for large-scale research support.

Establishment of hubs, centres and networks to support and enhance technology commercialisation, business growth, and investor confidence

Creating hubs and centres such as the Centre for Process Innovation (CPI), which serves as the primary hub for industrial biotechnology business support in the UK, facilitates technology commercialisation (Hodgson, et al., 2016). Hubs and networks provide essential resources and support including connecting researchers, businesses, and investors in each sector. These institutional support schemes are important for establishing the UK as a nation with strong institutional support for international R&I for technology commercialisation and business growth. For instance, the CPI has established partnerships with international research institutions and companies to foster innovation and technology transfer. An example is their collaboration with the UK-India critical minerals partnership, which focuses on developing sustainable solutions for the extraction and processing of critical minerals This partnership not only enhances technological advancements but also strengthens economic ties between the UK and India. CPI's global impact on transforming healthcare and driving towards a sustainable future includes supporting global innovation, investing in the future, building the STEM workforce, fostering global partnerships, and informing international industrial policies. CPI also provides access to world-class facilities and expertise for international R&I activities. Their facilities support a wide range of sectors, including biotechnology, pharmaceuticals, and advanced materials. By offering these resources, CPI helps international partners accelerate their research and bring innovative products to market more efficiently

4.2.2 The nature of reputation

The UK's reputation as an attractive destination with large-scale research support for international R&I

The UK is seen as a prime destination for international R&I due to its robust and large infrastructure and associated strategic plans, international agreements, and funding opportunities for national and international collaborative use and development of infrastructure. ISIS Neutron and Muon Source which support both national and international researchers, demonstrates the UK's capability to host large-scale research initiatives. As a founding member of the global project CERN, the UK engages with over 13,000 researchers from more than 75 countries, contributing to significant technological breakthroughs and bolstering its global scientific reputation. The UK is thus recognized as a leading hub for large-scale research support due to its advanced research facilities, extensive government investments in large-scale infrastructure, research, and significant involvement in major international projects.

UK's reputation of competitive advantages in key sectors

With large infrastructure, often in selected sectors, the UK holds competitive advantages demonstrating the country's reputation in key emerging sectors (Innovate UK 2023). For instance, supported by strategic infrastructure and associated investments in sectors like AI (e.g. Alan Turing Institute - the national institute for data science and artificial intelligence), fintech (e.g. Fintech Innovation Hub, the Europe's largest technology accelerator for finance, retail, cybersecurity, and future cities technology companies), and biotech (e.g. Stevenage Bioscience Catalyst (SBC), a world-class science park that supports the growth of biotech companies), the UK is home to 122 tech unicorns, ranking third globally and first in Europe, reflecting its globally competitive position in key technology areas (IRR 2023). Therefore, the UK's reputation in emerging sectors achieved through large-scale infrastructure supporting international R&I is likely to attract extensive collaboration and investment, enabling further strengthening of competitive advantages.

UK's reputation as a reliable/trusted partner for new multi-national infrastructure developments

The UK's substantial investment in large infrastructure facilities has significantly bolstered its reputation as a reliable and trusted partner for new multinational infrastructure developments. For instance, the UK's investment in research infrastructure, such as the recent £72 million funding by UK Research and Innovation (UKRI) for upgrading research facilities, underscores its commitment to maintaining world-class standards in science and technology. These investments ensure that the UK remains at the forefront of innovation, making it an attractive partner for international infrastructure development initiatives. The Diamond Light Source, the UK's national synchrotron science facility, is an example of the UK's large-scale infrastructure that supports international R&I. It attracts researchers from around the world who use its advanced capabilities to conduct cutting-edge experiments in fields ranging from materials science to biology. This facility not only fosters international scientific collaboration, technological advancements, and innovation but also makes the UK a trusted and reliable party for international infrastructure development. The success and reputation of Diamond Light Source have led to partnerships with other international research facilities and infrastructure projects. For instance, Diamond Light Source became a member of the League of European Accelerator-based Photon Sources (LEAPS), a strategic consortium of European synchrotron and free-electron laser facilities. LEAPS brings together 16 organisations that represent 19 facilities. These entities share a unified vision of promoting scientific excellence to address global challenges and collectively enhance competitiveness and integration. This goal will be pursued

through a sustainable strategy developed in collaboration with all stakeholders, including national policymakers, user communities, and the European Commission.

4.2.3 Impacts of generated reputation

Table 4.2: Impacts of reputation generated through UK's large-scale infrastructure facilitating international R&I

Types of Impact	Specific Impacts
1. **Financial Impact** - Increased Financial returns	Significant investments and long-term commitments from international investors and stakeholders.
2. **Relational Impact** - Improved useful and strategic networks and relationships	Enhanced international networks
3. **Resource Impacts** - Increased availability of resources	Enhanced opportunities to engage in joint international infrastructure development Enhanced exchange of resources, knowledge, and people
4. **Research and Innovation Impacts** - Increased research and innovation output	Increased opportunities to engage in large-scale international Research and Innovation

Case Study: UK Biobank: UK government investment in large-scale database offering global access

UK Biobank is a large-scale biomedical database and research infrastructure resource opened in 2012.

International R&I activities:

Since its inception, over 27,000 researchers from more than 90 countries have been using it. UK Biobank is a UK government investment aiming to provide state-of-the-art infrastructure with an extensive database, which includes anonymized genetic, lifestyle, and health information from half a million participants accessible to both national and international researchers. UK Biobank's infrastructure includes advanced data storage systems and secure management of consented participant data.

The Welcome-funded Research Analysis Platform (RAP) creates support for developing capabilities which allows researchers to access, store, and analyse UK Biobank data in-situ. The RAP also supports UK Biobank through advanced technology to manage the complex and large-scale data being generated, and facilitates access to researchers worldwide including from low-income countries. The platform has been utilized by approximately 700 access projects with over 2,000 users, exemplifying the extensive reach and impact of UK Biobank's data.

The open-access policy adopted by UK Biobank ensures transparency and maximizes the utility of research outputs, promoting widespread research advancements. Data accessibility has facilitated numerous research projects globally, contributing to significant scientific discoveries and advancements in health research. For instance, during the COVID-19 pandemic alone, 966 projects accessed UK Biobank data, resulting in 265 published papers with over 7,339 citations and 74,487 mentions in social media and news outlets. In addition, the resource has supported 530 patent filings, demonstrating its role in fostering innovation in novel methods, imaging, and therapeutics.

The nature of reputational impacts generated:

Biobank's commitment to independent audits, penetration tests, and compliance with data protection regulations ensures a stable and secure environment for research. Additionally, UK Biobank's adherence to the highest ethical standards and licensing by the Human Tissue Authority (HTA) further enhances credibility and reputation, increasing attractiveness for international stakeholders for collaborative R&I projects. The research infrastructure also showcases the UK's commitment to global advancement in this key sector, further encouraging collaborations and investments in the UK.

Source: UK Biobank Limited (2022)

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Acknowledgements

We would like to acknowledge and appreciate the efforts of the IRC Project Administration Team involved in proofreading and formatting, for their meticulous attention to detail and support, and to Kasuni Withthamperuma Arachchige for her outstanding research assistance.

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The IRC supports the use of robust evidence and insights in UKRI's strategies and investments, as well as undertaking a co-produced programme of research. Our members are leading academics from across the social sciences, other disciplines and sectors, who are engaged in different aspects of innovation and research system. We connect academic experts, UKRI, IUK and the ESRC, by providing research insights to inform policy and practice. Professor Tim Vorley and Professor Stephen Roper are Co-Directors. The IRC is funded by UKRI via the ESRC and IUK, grant number ES/X010759/1. The support of the funders is acknowledged. The views expressed in this piece are those of the authors and do not necessarily represent those of the funders.

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