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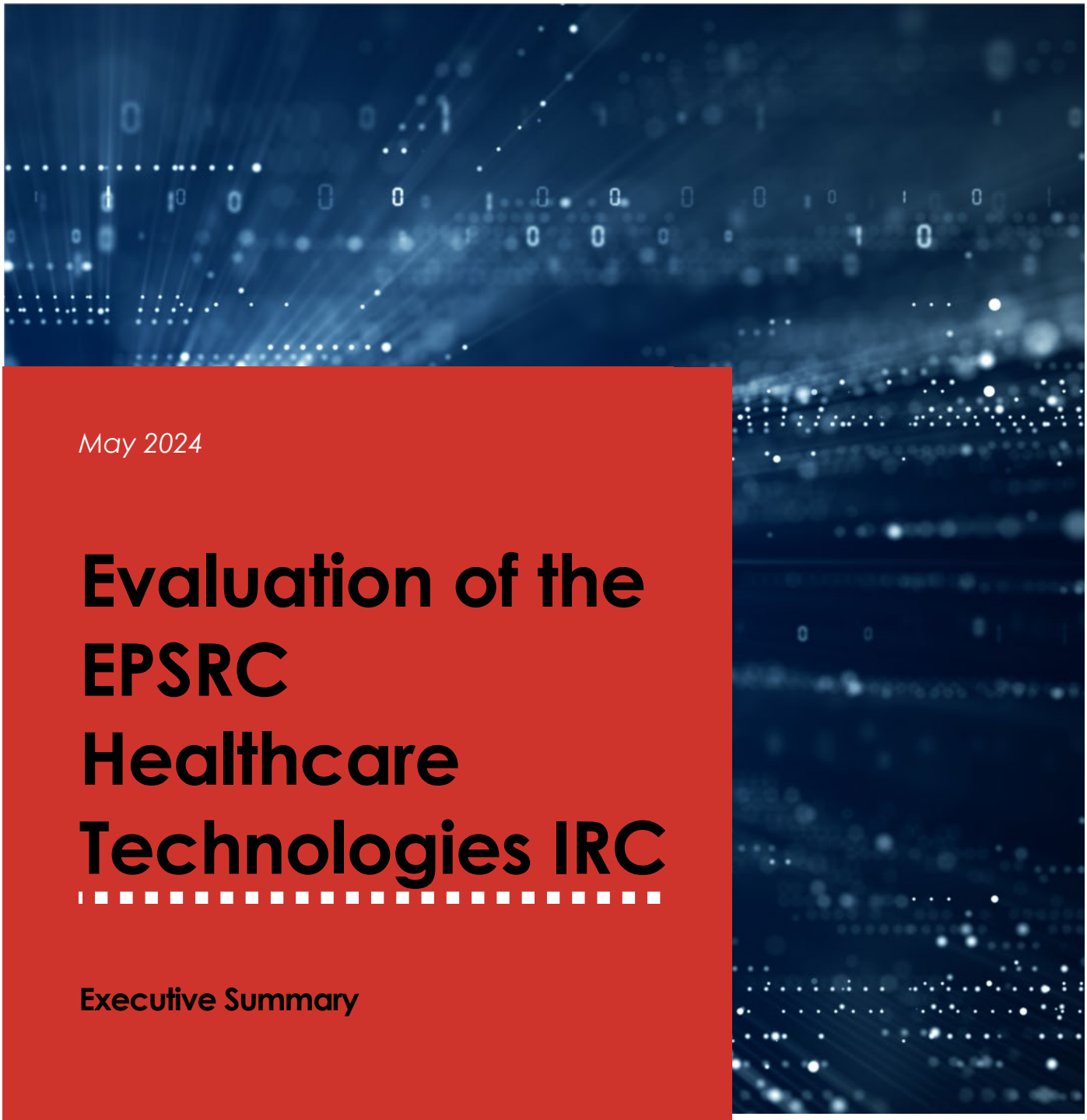

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Evaluation of the EPSRC Healthcare Technologies IRC

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Executive summary

Interdisciplinary Research Collaborations (IRCs) are networks of excellence aimed at attracting and building critical mass and breaking siloes across engineering, physical, and biomedical sciences. The Engineering and Physical Sciences Research Council (EPSRC) has played a key role in funding IRCs in areas of key future industrial relevance to the UK, including in healthcare technologies.

Overall, the Healthcare Technologies IRC funding represents a total investment of £59.1 million between 2013 and 2023. EPSRC funded three IRCs in sensing systems for healthcare in 2013 and renewed these in 2018. Additionally, it funded a fourth IRC in targeted therapeutic delivery in 2018. EPSRC also funded four Next Step Plus projects through a competitive process. The aim of these IRCs was to deliver preclinical and precompetitive projects, from basic applied research to early proof-of-concept projects, with potential for impact in health. The goal is to enable people to live healthier lives and to make an impact in future industrial areas for the UK.

The specific IRCs and related projects include:

IRC i-sense: Early-Warning Sensing Systems for Infectious Diseases; and Next Step Plus projects u-sense: Ultra-Sensitive Enhanced NanoSensing of Anti-Microbial Resistance; Smartphone mRNA: Smartphone Powered mRNA Sequence Detector.

IRC Proteus: Multiplexed 'Touch and Tell' Optical Molecular Sensing and Imaging; and Next Step Plus project Photonic Pathogen Theranostics: Point-of-care image guided photonic therapy of bacterial and fungal infection.

IRC SPHERE: Sensor Platform for HEalthcare in a Residential Environment; and Next Step Plus project OPERA: Opportunistic Passive Radar for Non-Cooperative Contextual Sensing.

IRC TeDDy: Targeted Delivery for Hard-to-Treat Cancers.

EPSRC commissioned Technopolis Limited to conduct an independent evaluation of its investment in Healthcare Technologies IRCs. The aim of the evaluation was to assess the outcomes and early indicators of impacts of the IRC programme and provide evidence of the advancements in knowledge generation, economic impact and societal benefits through a series of in-depth case studies. Additionally, the evaluation aimed to assess the programme's design, implementation and management. The evaluation was carried out between April 2023 and March 2024.

Methodology

The evaluation followed a theory-based, mixed methods approach, building on a logic model and an evaluation framework. Analysis of documents and monitoring data was complemented with data from stakeholder consultations. Quantitative data, where available, was combined with qualitative information to provide robust evidence and develop recommendations for EPSRC and the research community.

Secondary data analysis involved a portfolio analysis of the funded projects using data from Researchfish submissions by research leads and Dimensions data from Digital Science. Additionally, we conducted an online survey with all participants from the four IRCs, including academic research leads and co-investigators, industry partners, NHS hospital trusts and third-sector participants. We conducted a programme of in-depth interviews to further our

understanding of the nature and scale of the specific outcomes and impacts of the programme to develop case studies.

As with any evaluation, there were limitations that prevented the observation and aggregation of the full extent of project outcomes and impacts. This was partly due to the timing of the evaluation and partly due to the limited availability of comparable data in monitoring datasets and from interviews.

Results

The 10-year IRC programme has recently completed, and while many benefits will emerge in the coming years, the programme has already demonstrated success in achieving its stated objectives (detailed below) and has created important results and early impacts.

Creating new knowledge. IRC research projects have generated a wealth of new knowledge manifested in many different forms, including academic peer-reviewed publications, conference presentations, new research tools, methods and models, specialised knowhow and protected intellectual property. The IRC funding to UK researchers has enabled internationally leading, highly cited publications, among other types of research outputs. Over the 10 years, the IRC generated 683 publications, 30 new databases and datasets, 15 research tools and methods, 11 distinct software and technical products, and 11 intellectual property rights. These quantitative figures indicate the intensity of knowledge generation activities, while case studies provide evidence of the quality of these research outputs and outcomes.

Building critical mass. The scale of IRC investment enabled the attraction of exceptional talent to lead and collaborate in healthcare technologies across disciplines involving engineering and physical sciences. It has built unique capacity for the future by training over 150 early- and mid-career researchers through various skills and career development activities and creating a network of 110 established researchers in the UK. The convergence of expertise at this scale around shared interests, goals and vision has enabled the development of new sensing technologies and drug delivery systems for cancer. This progress was made possible by institutional support and existing infrastructure at collaborating partner organisations. It is likely that a much larger number of researchers will benefit from the programme in the future through the multiplier effect of upskilled and established IRC researchers.

Developing partnerships. The IRC programme created an initial network of 30 organisations in the first funding period (2013-2018) and expanded it to 73 organisations, now including IRC TeDDy, in the second funding period (2018-2024). A Partnership Resource Fund was established within IRC grants, which was particularly useful in bringing new UK partners into the collaboration and initiating new joint research activities. Over half of these organisations were UK universities and research institutes. The partnerships also brought skills and expertise from industry and included the perspectives of end-users (clinicians and patients) and policy makers. An analysis of IRC co-publication data pointed to limited direct involvement in research of industry, government and health facilities. However, it indicated the IRC's international leadership in healthcare technologies, with a third of its publications featuring with international authors.

Enabling translation to products and practices. The IRC programme was particularly successful in developing and progressing technologies of healthcare relevance due to its interdisciplinary research excellence, which helped to tackle large scale and complex challenges. The case studies developed through the evaluation illustrate the breadth and depth of these innovations and inventions. Patents have been filed, spinout companies have been created and investments have been raised on the back of these technological advances. These cover sensing systems for prediction of infectious disease dynamics, new diagnostic technologies for

the clinical environment and resource-limited settings, and multi-sensor technology for monitoring disease symptoms in daily life. Targeted drug delivery using various innovative approaches have also advanced, although integrating these into a synergistic system was not viable. The IRC programme was also able to progress specific technologies beyond Technology Readiness Level (TRL) 3 and apply them in fields extending beyond healthcare.

Informing the research landscape. IRC directors and co-investigators were members of key committees, contributing to high-level discussions, shaping policies and the national research landscape. These include topics such as information governance across the health and care system, deployment of digital healthcare technologies across the NHS, and the importance of long-term investment in engineering and physical sciences. The three original IRCs shared knowledge at an 'all IRC conference' in Bath in 2017, and IRC directors were members of each other's mid-term review boards.

Achieving sustainability. The achievements of the IRC programme are expected to be sustained and grown over time through securing additional funding from a mix of public and private sources. This will ensure that these virtual 'national centres of excellence' will become self-sustaining, allowing partnerships to continue collaborating on tackling new challenges. The evaluation has shown that the four IRCs have already raised a total sum of over £150 million from public and private funding sources for follow-on research and development projects, which is 2.5 times the overall IRC investment. A portion of this additional funding is specifically provided by funders and investors to create and grow the six spinout companies from the IRCs, further exploiting the technologies developed in the IRCs. Another role for this leveraged funding is to create new EPSRC Centres for Doctoral Training at the interface of health sciences and engineering, sharing the knowledge and tools developed by the IRCs, and creating interdisciplinary skills supply for improved R&D capacity in the UK.

Recommendations

To maximise the future impact of similar large-scale research programmes, the following points and actions may be considered by EPSRC.

1. Improve the potential for translational impact

1.a Explore and better understand the role industry can play in TRL1-3 research. Currently, a low level of industry engagement was visible in this evaluation. It may be unfeasible for large multinationals to extract value from early-stage, proof-of-concept research. A larger Partnership Resource Fund could enable companies to collaborate on high-risk joint research projects.

1.b Explore further funding options for researchers to help them to progress their technologies towards deployable solutions beyond project end. This may involve advocating for investment more widely into healthcare technologies as a 'joint programming initiative' and convening interested (public and private) funders to this end. For example, very few trials appeared to test the safety and efficacy of technologies developed by IRCs. Potential co-funders may include the NIHR, Wellcome and Cancer Research UK.

1.c Link IRC spinouts to dedicated funding agency support. Spinouts that receive funding from the British Business Bank and Innovate UK are more likely to succeed. These spinouts also received higher levels of private 'follow-on' equity capital. Nurturing spinouts in the UK will help reduce the negative impact of research outputs taken abroad for commercialisation. Taking an active role in connecting IRC spinouts to seed funding via the UK Innovation and Science Seed Fund may also be considered.

1.d Link research projects with the UK Catapult network, which provide support to both academia and businesses in bringing research to market more quickly. They offer specialist programmes to upskill researchers, provide specialist infrastructure, testbed and demonstration environments, among other resources. However, healthcare technologies may not have a 'natural home' among the current Catapult Centres.

2. Embed the programme better in the training & international research landscape

2.a Encourage researchers to connect better with world leaders in their thematic areas of interest. Mobility Fellowships have demonstrated how UK researchers benefit from visiting international organisations to enhance research excellence. This can also contribute to growing the UK's global leadership in healthcare technologies while recognising the need to protect UK intellectual property.

2.b Encourage researchers in funding calls to connect with relevant Centres of Doctoral Training and support nurturing new talents as part of the drive to create improved R&D capacity in the UK. This is particularly timely as EPSRC is investing in training over 4,000 doctoral students over nine years in critical technologies.

3. Improve the monitoring practices

3.a Develop a core set of common indicators for large-scale programmes, such as the IRCs, through inclusive stakeholder workshops, and link these to expected research outcomes across all objectives. Projects should record and collect such monitoring data and provide it annually to EPSRC. Improved monitoring practices would not only support future evaluations but also provide ongoing formative learning opportunities for project leads. It is important that the IRC management teams retain flexibility to manage such large-scale investments while adhering to robust monitoring and accountability mechanisms. It is suggested that large-scale investments have agreed, clearly defined, time-bound milestones to help achieve project objectives, and that associated metrics are in place to track progress. Reviewing these milestones could help to make efficient funding decisions for research strands within large-scale projects.

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