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Final Report

Appendix D DHI

ADDITIONAL RESEARCH

March 2023

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Appendix D. DHI (Digital Health & Care Innovation Centre).

1 Introduction.

The purpose of DHI is to collaborate with partners to identify and develop transformative digital innovations ready for adoption, to improve health and care, and provide sustainable and inclusive growth for Scotland[1]. DHI was one of the earliest Innovation Centres and was set up in 2014, with Phase 2 funding approved in April 2019.

2 Development and approach.

2.1 Main elements of Phase 1.

DHI's approach to innovation in Phase one evolved through two stages: Phase 1a and Phase 1b, characterised by different approaches adopted and outputs delivered. The work delivered in Phase 1a was primarily supply driven, focusing on industry-led innovation proposals and product optimisation. The Phase focused on business engagement and project related activities. In terms of business engagement:

- DHI ran open calls for proposals. Over time this evolved to include specific call topics which were defined in partnership with NHS Boards to address health and social care priorities in Scotland (e.g., diabetes, outpatients redesign, dementia).
- DHI moved towards a 'dual system' for supported projects: 'strategic challenges' (65%) – work organised by identified strategic theme/challenge, and 'sandpit' (35%) – a smaller stream of organic project intake, as per the original model.
- DHI maintained a 'Business Development' team that engaged with industry, HEIs and civic partners.
- DHI was also engaged in a wide range of events and conferences held in Scotland, UK and Internationally –attending, speaking and exhibiting (see MEF reporting below).

In terms of projects:

- All DHI supported projects were required to demonstrate academic, business, and civic value. The ideal was for each project to have an academic, industry and civic partner – bringing together people and organisations in the health and social care, charity, technology, design and academic sectors to develop new ideas for digital technology and information services that would improve the delivery of health and care services.
- There were three main components of the activity pipeline, and depending on the project's maturity, it was allocated as follows:
    - Exploratory (early stage).
    - Laboratory (initial development stage).
    - Factory (advanced development).

In addition, DHI worked with a number of universities to deliver skills development activities, such as the SFC Highly Skilled Workforce Scholarship programme in the 2015/16 academic year.

It is noted that in January 2017, SFC agreed to a Phase 1b, and there was a shift of focus from being 'industry facing' to a greater focus on the NHS as customer and on the delivery of outcomes set by the Scottish Government Health and Social Care Department (SGHSCD). In line with the offer letter from SFC, DHI closed the Phase one term early on 31 March 2017 and commenced Phase 1b on the

[1] Digital Health and Care Institute (2019) DHI Business Pan 2019-2024, Transforming great ideas into real solutions, DHI: Glasgow.

1st of April 2017. It is noted that a large number of Phase one projects remained on-going with KPIs to be delivered during the Phase 2 period. Phase 1b represented a transition to Phase 2.

The Phase 1b shift towards demand-led challenges was recognised by DHI as offering a more impactful approach within the public sector dominated health and care system. While a large number of projects were successfully completed, "very few of them successfully scaled" [27], as noted by a senior DHI official, citing barriers to market entry in the public sector dominated health market. The alternate approach resulted in a more focused and in-depth portfolio of seven service-led challenges, mutually agreed by DHI and the Scottish Government.

2.2 Main elements of Phase 2 business plan.

The overall aim of Phase two is to collaborate with partners to identify and develop transformative digital innovations ready for adoption in the NHS and care sector and to capitalise on Scotland's growing digital technology sector to support the required transformation of health and care services in Scotland[2]. As set out in the DHI business plan the main focus is on addressing societal challenges across healthcare via digital tools and services, with tangible benefits for health and well-being which can also create economic advantage and contribute to the growth agenda.

The outcomes are in line with Scotland's Digital Health and Care Strategy published in April 2018 and DHI is identified as a partner in the delivery of this strategy. DHI intend to deliver through four key areas, as set out in the Phase 2 business plan:

1. **Innovation clusters:** Building a multi-sector innovation cluster (c600 participants targeted initially) which effectively collaborates to address key barriers and develop solutions for three challenge opportunities set in collaboration with the SGHSCD.
2. **Project portfolio:** Delivering a portfolio of approximately 10 significant innovation projects in response to key demand-led challenges, making two projects ready for mainstream adoption over the period of this plan.
3. Maintaining the development of **DHI Exchange** (previously Demonstration & Simulation Environment (DSE) as a national R&D resource for two years to simulate, test and demonstrate the digital innovation products for health and care services, and to ensure that the activities and projects align with Scotland's national digital architecture.
4. **Skills, future workforce and knowledge exchange:** Delivering a programme of knowledge exchange and skills development to influence the curriculum within schools, and further and higher education to ensure Scotland's future workforce is able to deliver care (with a target of 20 MSc studentships between seven partner universities).

2.3 Evaluation logic model.

The current approach of DHI, as presented in the Phase two business plan, is summarised in the figure below (see Figure A. 1). The basis for this model, is the DHI Phase two business plan, adapted by the authors to conform with a consistent logic model terminology. Wider benefits for health and well-being are not explicit in the model.

[2] Scottish Funding Council (2019) Innovation Centre programme phase 2 approval paper, SFC/19/24, Agenda item 10, 5th April, SFC: Edinburgh.

Figure A. 1 DHI logic model (Phase 2).

Context

Across the world, the digital health and social care sector is multifaceted and economically significant, valued at $150 billion in 2015 and predicted to increase to $431.7 billion by 202413. From a UK perspective, the market size for digital health is forecast to reach £2.9 billion in 2018, increasing from £2 billion in 2015. With over 139 IT companies active within the healthcare sector, Scotland is well positioned to take advantage of the opportunities for digitally powered growth.

The growth of digital health and care in Scotland has increased substantially in recent years, underpinned by Scottish Government policy and investment. At a strategic level, the importance of technological advances to health, care and the economy have featured in many of the Scottish Government key strategies and plans, including, for example: A Digital Strategy for Scotland; Scottish Digital Health and Care Strategy; Health & Social Care Delivery Plan and others.

The publication of 'Scotland's Digital Health and Care Strategy' (DHC) in April 2018 signalled a significant shift in ambition for digital health and care services in Scotland reflective of a view that 'Digital technology is key to transforming health and social care services so that care can become more person-centred'.

Market failures

DHI is a key enabler between industry providers, providing direct links into complex health and care systems across Scotland and generating collaborative opportunities for innovation activity. DHI the recognise the following five key barriers to adoption of digital innovation within health and social care: limited capacity for change and adoption; unfocused cross-sector collaboration; limited exploration and testing in context; lack of common standards & interoperability; low digital literacy and skills gaps; as well as current technical architecture and information governance, and low digital knowledge and skills gaps.

Core Objectives

1) Primary objective: harness digital innovation to support the essential transformation of health and care services in Scotland, supporting readiness for adoption, with a national reach across all of Scotland.

2) Secondary objective: creating significant opportunities for industry and academia to gather insight, evidence impact and gain national and global market traction.

Inputs - (Phase 1&2)

- SFC Phase1 spend- £15.7 m
- SFC Phase 2 Award £7.5 m
- SGH&SC Phase 2 Award £2.5 m

- **Total inputs - £25.7m.**

Outputs

- Number of attendees at DHI knowledge exchange and innovation events.
- £ Investment secured.
- Number of demand driven digital products.
- Number of collaborative projects by urban /rural theme.
- Number of innovations introduced into services.
- Number of reports publications and business cases.
- Number of individuals gaining new qualifications or skills.
- Number of businesses that have inward invested (£).
- Number of businesses that have exported (£).
- Shift in public /political /educational discourse.

Main Activities

- Cutting-edge market research
- Global trend analysis
- Current & future service mapping
- Co-design research activity
- Academic grant awards
- Specialist project management
- Interactive prototyping Technical dev. and testing
- R&D demonstration environment
- Digital skills and workforce development
- Industry collaboration
- Influential knowledge exchange
- Hosted study visits
- Specialised event management
- Production environment for live trials
- Innovation cluster facilitation and management
- Business change management
- Assets to stimulate business to business cooperation
- Expertise and influence to reframe digital in trust and agency terms

Outcomes & Impacts

- A multi sector collaborative innovation cluster to accelerate digital innovation and adoption.
- A project portfolio of digital innovations that empower citizens and sustained public services.
- A demonstration on simulation environment which proves new data sharing methods can support preventative ,personalised care.
- A programme of digital health and care skills development to support workforce comfortably using digital to deliver citizen centred services.
- An acceleration of digital innovation and adoption into health & care
- Digital interventions empower citizens and create service capacity
- Effective data exchange takes place between consumer & public systems, supporting integrated and preventative care
- Digital innovation is embraced by the workforce as a fundamental component of 21st century health and care delivery
- Scotland attracts greater digital investment
- The Scottish population has greater choice and control of the way they interact digitally

Source: adapted from DHI Phase 2 business plan.

3 Market failure and strategic fit.

3.1 Market failure rationale.

An early review by DHI of the Phase 1a industry-led approach, identified difficulties implementing these innovations in Scotland. Several reasons for this were identified, for example, the NHS and social care providers were often not in the required state of readiness to adopt them successfully. One DHI representative commenting, that DHI plays an important role in informing the NHS of available relevant applications and how they may be implemented in ways that improve service delivery and improve productivity [61]. Another commenting, that a different mind-set, culture, and skill set was required (than that available in the NHS) to enact service re-design [27]. In addition, rather than pushing, a supply-led effort, to introduce digital health and social care innovation, there was recognition by DHI, that they needed to be more of a 'pull' organisation, where they worked with NHS to create and shape demand [27, 12].

This experience reframed DHI in Phase 1b, recognising that for innovation to make an impact, the wider health and care system must be "ready, willing and able to adopt"[3]. The DHI role is presented as an approach that "de-risks" innovation of the NHS [27]. That barriers for suppliers in gaining access to the NHS persists was mentioned by a DHI board member, commenting that, in general terms, "The NHS is impenetrable for Scottish industry", and outlining that DHI represents an important avenue and enabler for Scottish industry [12]. Another DHI representative highlighted the added value of their work in creating new opportunities for Scottish suppliers that would be otherwise absent (and that they are therefore also not displacing any actors [27]).

While not explicitly stated as such, DHI activities may be justified in terms of several aspects of market failure. These include the *efficiency* considerations of *information failure* (in this case, developing the conditions for wider identification and adoption of good practice for productivity gains in the NHS in the digital health and care arena) as well as the *positive externalities* associated with new products, services and processes that deliver health and social benefits. There are also *public good* arguments for the work of DHI which deliver benefits which are not commercial in nature and flow beyond the individual organisations and businesses involved in R&D.

The relevance of wider intervention drivers is also clearly evident in the objectives of DHI including those of *coordination failure* (in fostering links between academia, industry, the public sector and citizens), as well as *opportunity* (for priming the NHS to adopt and roll out new product and service innovations).

When questioned directly DHI clients cited a range of factors constraining their establishment's innovation activities before working with the Innovation Centre. The five greatest barriers to innovation, prior to working with the IC were cited as:

1. Lack of qualified personnel support or project/programme support (30% of respondents cited this).
2. Availability of finance, including awareness of funding opportunities (20%).
3. Procurement challenges (20%).
4. Lack of information on technology (17%).
5. Ability to work collaboratively with competitors on a shared challenge (17%).

3.2 Strategic fit.

DHI demonstrates strong alignment with the strategic landscape, including the Scottish Government's Programme for Government emphasis on wellbeing and "further strengthening Scotland's life sciences sector's ability to innovate and to support Scotland's NHS". It has been noted that in Phase 2 there

[3] Digital Health and Care Institute (2019) DHI Business Pan 2019-2024, Transforming great ideas into real solutions, DHI: Glasgow.p15.

was a shift of DHI focus from being 'industry facing' to a greater focus on the NHS as customer and on the delivery of outcomes set by the Scottish Government Health and Social Care Department (SGHSCD) and that this alternate approach has resulted in a portfolio of service-led challenges, mutually agreed by DHI and the Scottish Government.

DHI's Phase two business plan also noted that, at a strategic level, the importance of technological advances to health, care and the economy have featured in many of the Scottish Government key strategies and plans, including:

- Scottish Government – Programme for Government 2018/19.
- A Digital Strategy for Scotland.
- Scottish Digital Health and Care Strategy.
- Health & Social Care Delivery Plan.
- Technology Enabled Care Delivery Plan.
- Life Science Strategy for Scotland: 2025 vision.
- Realistic Medicine.
- Public Sector Reform in Social Care.
- Scottish Government Economic Action Plan 2018-20.

Alignment with wider UK strategies was also set out including the Life Sciences Industrial Strategy, and UKRI's Industrial Strategy.

In December 2020, DHI was invited to join the NHS Scotland Innovation Steering Group to provide leadership, support and guidance to the development and implementation of an enhanced system for innovation across NHS Scotland and for supporting Scotland's post Covid-19 economic recovery[4].

It is noted that the private and voluntary sectors now employ over two thirds of social service workers, although the share varies widely by local authority area[5]. There are some service types (such as care homes for adults, housing support / care at home and offender accommodation services) where the majority of the sector is employed by the private or voluntary sector. As such, it is likely there will be growing demand and opportunities for a range of business start-up and business growth for private and third sector/social economy organisations. While it is acknowledged that individual DHI projects and networking activities engage with both the private and third sectors, this context perhaps suggests opportunities to further extend the scope of engagement with private and third sector providers.

Furthermore, the care sector has been identified as an important 'Locally Traded Sector'[6]. A key characteristic of these is the ability to generate employment locally, and to have a significant influence on the economic performance of local areas in terms of sustainable employment and incomes. However, these sectors also exhibit generally low skill, pay, and productivity levels. In this context, it is important to examine how health and social care service delivery efficiencies interact with local authority priorities for employment and income generation (e.g., ensuring maximum uptake of training and employment opportunities by local residents, maximising local supplier opportunities, and linking public sector productivity support to community benefit clauses that promote 'backward linkages' to local businesses and people).

3.3 Covid response.

Covid saw a significant shift in the strategic orientation of DHI. In line with all ICs, DHI experienced a challenging operating environment during the period 2020-22 as a consequence of the Covid-19 pandemic. The challenges presented by the pandemic for wider society were strongly relevant to DHI's core areas of focus and were met with accelerated development and adoption of digital services and solutions in collaboration with their funders and partners.

[4] DHI (2021) DHI's response to Covid-19 pandemic emergency years (2020/2022), DHI: Glasgow, p11.
[5] McPherson, A (2015) Discussion paper on care sector, Improvement Service: Livingston.
[6] Infernal Scottish Enterprise paper on Locally Traded Sectors.

In March 2020, DHI reviewed their priorities to create staffing capacity and pivoted their approach to help address Scotland's response to Covid-19, where DHI became a fundamental part of the Scottish Government's national response to the Covid-19 pandemic.

The work reflected the four main pillars of DHI activities. Under the innovation cluster pillar, the Centre liaised closely with public sector delivery partners, academic and industry. It is noted that key senior members of DHI were directly involved in advising Scottish Government on the digital aspects of the health and care response through involvement in strategic, operational and governance groups as well as 1:1 advisory activities with senior officials[7].

Under the project portfolio and DHI Exchange pillar, five new Covid-19 projects were initiated with three of these quickly scaling to become a fundamental part of the Scottish Government's digital response to Covid-19 (including, for example, the national Notification Service (NNS) which is now a core part of the Test & Protect approach; Simple Tracing Tools (STT) permitting the digital means to capture contact tracing data; Covid-19 Community Co-Management (Co3) permitting community contribution of contract tracing information; and Covid-19 Decision Support Tool- a suite of decision-support tools). Two large-scale initiatives already in DHI's project portfolio (The Right Decision Service platform and SCOTCAP (Scottish Capsule Pill Programme)) were adapted to support the Covid-19 response.

An additional £3.1m investment was leveraged from the public sector into DHI, meeting their five year business plan target of £3m (i.e., non-core grant funding) significantly ahead of time December 2020.

Under the 'skills, future workforce, development and knowledge exchange' pillar, the centre published a range of rapidly produced market research related to Covid-19, led and participated in a number of international knowledge exchange events, supported some 27 innovation bids during the period Jul 2019-Dec 2020, and engaged in a range of workforce development initiatives with partners from universities, colleges and the public sector including Skills Development Scotland.

Further supporting initiatives which build on and enhance Covid-19 legacy projects and other activities under the four pillars, were scheduled for the 2021-22 period. Elements of the Covid-19 project portfolio will continue into 2021/22 (DHI Year 3) with transitions from Covid-19 facing products to wider generic applications, leveraging emergency investment as legacy for wider recovery purposes.

4 Inputs, activities and outputs.

It is important to set the context here for limitations of MEF with regard to health and societal impacts. The MEF, as it stands, is of limited applicability to these. A number of stakeholders were keen to emphasise that these benefits should be seen on a par, albeit health and societal impacts are harder to quantify and report on quarterly/annually.

4.1.1 Funder Inputs.

DHI funder inputs are noted below. SFC Phase one spend totalled some £15.7 million. Phase two awards total £10 million (SFC £7.5 million, Scottish Government Health & Social Care Directorate £2.5 million), with £7.5 million actual spend to date. This relates to funders only and does not reflect any other leveraged funding and assumes all funder contributions by purpose (i.e., core funding or project related).

[7] DHI (2021) DHI's response to Covid-19 pandemic emergency years (2020/2022), DHI: Glasgow.

Table A. 1 DHI inputs to March 2023.

	Phase 1 Spend	Phase 2 Award	Phase 2 Actual to Date	Total Spend to Date
SFC	£15.7 million	£7.5 million	£5.5 million	**£21.3 million**
Scottish Government Health and Social Care Directorate	-	£2.5 million	£2.5 million*	**£2.5 million**
SE	-	-	-	-
HIE	-	-	-	-
Total	£15.7 million	**£10.0 million**	£7.5 million	**£23.7 million**

*Source: SFC, SE, HIE correspondence ('Summary funders awards and drawdowns to date', excel spreadsheet, Feb 2023). * funders indicate awarded at outset of Phase 2.*

4.1.2 Activities and outputs.

Skills.

Individuals gaining new qualifications or skills have increased substantially during the course of Phase two to date, for example some 64 master's qualifications compared to 16 in Phase 1 (Table A. 2). Phase two has also witnessed an expansion of online training, contributing to the large 'other' category.

The MEF may understate the total number. DHI note that since 2015, we've supported 120 students at 10 unis across 18 subject areas/courses (including Global eHealth, Digital Health Systems, Health Psychology and other areas). Some 45% of scholarships have gone to the University of Strathclyde, 19% to Stirling, 8% to Edinburgh, 7% to GSA. Some 81% of these have been taught Masters, 19% MRes or other[8].

Table A. 2 DHI: number of individuals gaining new qualifications/skills.

Level	Phase 1 (a & b)	Phase 2	Total
PhD/EngD	4	0	**4**
MSc	16	64	**80**
HNC/HND	4	0	**4**
Other	1,031	4,858	**5,889**
Total	**1,055**	**4,922**	**5,977**

Source: MEF(Phase 1 to Jul 2019, Phase 2 Jul 2019 to Jul 2022).

Skills development activity is notable by an expansion of entrants to education/ training. Supported master's entrants reached 71 to date during Phase two, up from 23 in Phase one. Increasing participation through other online training is also evident during the course of Phase two, boosting the 4,858 'Other' category. It is noted the low number of 'other' entrants for Phase 1 does not match the numbers qualifying , so may understate the number of entrants (see Table A. 3).

Table A. 3 DHI: number of entrants to education/training.

Level	Phase 1 (a & b)	Phase 2	Total
PhD/EngD	5	0	**5**
MSc	23	71	**94**
HND/HNC	4	0	**4**
Other	4	4,858	**4,862**
Total	**36**	**4,929**	**4,965**

Source: MEF

Networking and ecosystem linkages.

Consistent with the planned innovation cluster activity in Phase one and two, DHI has maintained an extensive programme of engagement events as indicated in Table A. 4. It is noted that DHI currently

[8] DHI correspondence.

maintains a cluster membership of some 1,551, with a broad membership across academia, the health and care sector, and the commercial sector (see Table A. 5). In terms of a breakdown of the commercial sector by organisational size some 78% are SME[9].

A moderate level of signposting to other innovation ecosystem partners is indicated in Table A. 6. In Phase 2 this is mainly to other public funding or support bodies, rather than the enterprise agencies (e.g., research funding bodies).

Table A. 4 DHI: number of engagement events led or delivered by IC.

Level	Phase 1 (a & b)	Phase 2	Total
> 100 Attendees	34	9	**43**
10-100 Attendees	48	47	**95**
< 10 Attendees	0	0	**0**
Total	**82**	**56**	**138**

Source: MEF

Table A. 5 Network membership by category.

Member category	Number	%
Academia	391	25
Health & Care Sector	313	20
Commercial	550	35
Charity/CIC	30	2
Other/Citizens	267	17
Total	**1,551**	**100**

Source: DHI

Table A. 6 DHI: follow on from completed collaborative projects.

Level	Phase 1 (a & b)	Phase 2	Total
Signposted to SE	6	3	**9**
Signposted to HIE	6	0	**6**
Signposted to other public funding/support body	8	25	**33**
Signposted to private sector	4	0	**4**
IC supported follow-on project planned or underway	7	2	**9**
Direct to market (by a business in Scotland)	5	3	**8**
Projects not taken forward	4	0	**4**
Total	**40**	**33**	**73**

Source: MEF (Phase 1 to Jul 2019, Phase 2 Jul 2019 to Jul 2022).

Collaborative project activity.

In relation to Phase 1 collaborative projects, discussion with DHI indicated that available MEF data significantly understates the number of projects. Collaborative projects were a core focus of Phase 1a, although a precise figure is not available from the MEF. As discussed earlier, a shift in approach to fewer, bigger projects, in collaboration with public sector partners has seen 24 completed collaborative projects to date in Phase two, with four in the pipeline (see Table A. 7). It is noted the projects are delivered via a number of funding mechanisms:

- Core funded (Core) – Defined as funds exclusively allocated from the DHI core budget.
- Joint funded (Joint)– Defined as a mixture of DHI core (in-kind) and additional funding contributions.
- Additional funded (Add) – Defined as commissioned and leveraging additional funding.

[9] DHI correspondence.

Table A. 7 DHI: collaborative projects.

Level	Phase 1	Phase 2		
	No. of collaborative projects (including completed)	No. of new collaborative projects	No. of continuing collaborative projects	No. of completed collaborative projects
Academic/IC to business (involving at least 1 business in Scotland)	N/A	3	0	**5**
Academic/IC to business (involving no businesses in Scotland)	N/A	1	0	**3**
Academic / IC to Academic	N/A	0	0	**0**
Business to business (involving at least 1 business in Scotland)	N/A	0	0	**0**
Academic/IC to public sector (involving no businesses in Scotland)	N/A	12	0	**9**
Academic/IC to public sector to business (involving at least 1 business in Scotland)	N/A	9	0	**7**
Individual Projects	N/A		0	**0**
Total	**17***	**25**	**0**	**24**
Collaborative projects in the pipeline	0	N/A	N/A	**4**

*Source: MEF . N/A- not available. *underestimate.*

Commercialisation.

As may be anticipated from the change in strategic approach of DHI between Phase one and two, the number of collaborative projects leading to the intention to commercial launch/application is moderate at 14 to date in Phase 2, and at 28 for the whole of Phase 1 (Table A. 8).

Table A. 8 DHI: number of IC collaborative projects leading to intention to commercial launch/application.

Level	Phase 1 (a, b)	Phase 2	Total
New or improved products developed (with/for a business in Scotland)	7	7	**14**
New or improved processes (with/for a business in Scotland)	5	1	**6**
New or improved services developed (with/for a business in Scotland)	4	0	**4**
New or improved business models (with/for business in Scotland)	5	1	**6**
New or improved delivery of a public service in Scotland	7	5	**12**
Total	**28**	**14**	**42**

Source: MEF (Phase 1 to Jul 2019, Phase 2 Jul 2019 to Jul 2022).

In terms of engagement with DHI, under half of respondents (46%) first interacted with the IC in or before 2018 (broadly consistent with Phase one). All client respondents were still involved with DHI at the time of the survey, indicating the long-term nature of engagement, and over a fifth (21%) have been involved with the IC for five years or more.

There are high levels of collaborative project involvement activity with clients. For DHI, some 63% of respondents were involved in a collaborative project with more than one partner. Some 60% were in collaboration projects with one partner**.** Some 30% were also involved in consultancy projects.

It is noted that just 3% of respondents had taken postgraduate internships/ placements/secondments (as high as 61% for The Data Lab). However, many clients have also accessed lower intensity support e.g., 27% for advice and signposting, 47% conferences and events, 23% training and development support. Overall, relatively few (13%) had accessed lab, test or demonstration facilities.

For collaborative project support, around 23% had accessed four or more rounds of DHI funding. More typically clients accessed one or two rounds of IC support (38%). It is also the case that survey beneficiaries have often engaged with other ICs, particularly The Data Lab, CENSIS, IBioIC, and PMS-IC.

The client survey demonstrates utilisation of a range of universities. Clients tended to engage most often with the Glasgow School of Art) but not exclusively so. Glasgow University was also an important partner. Just 3% of respondents to the client survey had worked with the host institution, Strathclyde University.

Engagement with colleges is on a smaller scale. Of the three respondents who did work with a college, these included Edinburgh College, Fife College and West Lothian College.

However, DHI note that from internal records, they have worked with 70% of universities in Scotland and over 60% of colleges since their establishment[10].

5 Outcomes and impacts.

5.1 Main findings from MEF.

A limited range of outcome and impact data is recorded in the MEF for DHI. It is important to again set the context here for limitations of the MEF with regard to health and societal impacts. The MEF, as it stands, is of limited applicability to these. Wider benefits, including health outcomes/ impacts are commented on in a later section.

Phase 1 and 2 outcome indicators for 'Anticipated jobs supported / created', and 'Anticipated turnover supported / created', are not reported on by DHI, in line with the changed approach adopted during the course of Phase 1b and Phase 2. However, DHI records significant levels of new posts created (HEI and public sector-based) to support demand- led academia-business projects (Table A. 9).

Table A. 9 DHI: posts created in Scottish HEIs/colleges/public sector.

Level	Phase 1 (a & b)	Phase 2	Total
New posts (in Scottish HEIs) created to support demand led academia-business projects.	N/A	12	**12**
New posts (in Scottish colleges) created to support demand led academia-business projects.	N/A	0	**0**
New posts (in Scottish public sector) created to support demand led academia-business projects.	N/A	5	**5**
Total	**N/A**	**17**	**17**

Source: MEF (Phase 1 to Jul 2019, Phase 2 Jul 2019 to Jul 2022).

5.2 Main findings from surveys of beneficiaries.

5.2.1 Outcomes.

The client survey provides further information on outcome and impacts.

In terms of influence on relationships, DHI has played a significant role in developing client relationships with a wide range of bodies relevant to the innovation ecosystem. Selected benefits include:

- Some 40% of respondents indicate DHI has significantly supported clients to developed better relationships with other clients or customers from the public sector.
- 33% of respondents indicate DHI has significantly supported relationships with universities or colleges.
- 30% of respondents indicate DHI has significantly supported relationships with clients or customers from the private sector.
- 30% of respondents indicate DHI has significantly supported relationships with government or public research institutes.

[10] DHI correspondence March 2023.

- A further 30% of respondents indicate DHI has significantly supported relationships with suppliers of equipment, materials, services, or software.

DHI client establishments invest in a wide range of innovation activity. For instance, half of client respondents engaged in design activity of some form since working with DHI (and in eight out of 15 cases the clients indicated DHI played a significant role in this activity). Just under half of those surveyed carried out internal R&D since they started working with the IC (in eight out of 14 cases the clients indicate DHI played a significant role in this activity).

Overall, 48% of client survey respondents had introduced new or significantly improved goods, services or processes since working with DHI, and 43% attributed these to DHI support.

Further, some 40% of DHI clients have introduced new or significantly improved services since they started working with the IC, and one in five (20%), new or improved goods. A further 17% had introduced new processes. Where these have occurred, the IC has typically played a significant role i.e., 10 out of 12 cases, five out of six cases and four of five cases respectively. However, it is noted that some 43% of respondents did not introduce any of the listed innovation outcomes. In terms of context, this may reflect the nature of long run processes associated with technology adoption into the NHS (as exampled below though projects such as SCOTCAP), which in some cases, can be very different from a business adopting a specific technology solution. None of the responding clients identified new start-up or spin out businesses or patent activity (which given the intensity of work with the public sector, is not surprising).

Some 65% of client survey respondents identified significantly improved aspects of networking benefits attributed to DHI (including number of business, academic public or third sector contacts).

A range of broader **networking benefits** are also cited (where the DHI played a significant role), including:

- New business contacts - 33% of clients saying this.
- New public sector contacts - 33%.
- Joint venture with business - 33%.
- New academic contacts - 23%.
- Joint venture with academic institution - 20%.

It is noted that 46% of client survey respondents identified significantly improved aspects of knowledge benefits attributed to DHI (including improved awareness of academic capabilities, public or private sector support).

Clients also identified a range of wider **knowledge benefits**, such as:

- Improved technical understanding of priority technology areas in my sector – 47%.
- Improved industry or technology foresighting – 40%.
- Improved cross-industry collaboration – 37%.
- Improved market understanding of priority technology areas in their sector- 33%.
- Improved awareness of academic capabilities – 27%.
- Improved employee skills and ways of working – 23%.

It is noted that those clients involved in collaborative projects through DHI have typically started at the lower end of the TRL scale (it is noted this may include project work before IC involvement). Some 75% of projects were at TRL 1-2 at the start. Interestingly, when clients look forward to the next three years, those at TRL 7-8 are expected to account for 71% of the total. In all, some 72% of clients thought DHI was very or extremely important in advancing their project TRL.

5.2.2 Impact.

The impact referred to in this section are employment and associated GVA impacts. As noted previously, DHI's health and societal impacts are viewed are regarded by some stakeholders as on a par, and these are further discussed in following sections.

The DHI operational plan (2013) reported that by 2018 DHI would generate: economic value up to £1bn per annum, increase sales and new product revenues up to £208m, create the potential for up to 725 new jobs in Scotland, and create the potential for as many as 30 new Scottish companies. In the MEF, the impact targets were subsequently reported at the end of the initial term to be 638 jobs and £91.5m revenues[11].

Analysis towards the end of the Phase one period noted that progress against output targets was positive, albeit with some delays due to the change in host university. However, the analysis also noted that progress against the outcome targets was difficult to evidence and also pointed to gaps in the quarterly MEF reports, making it difficult to provide an overall assessment on progress during Phase 1.

An assessment of additionality was included in the client survey**. Some 88% of client survey respondents attributed full or partial additionality of benefits to DHI**. In all, 4% say they would not have achieved any of the benefits without DHI support (absolute additionality), whereas 12% say they would have achieved the same benefits at the same time and scale without the IC support (zero additionality).

However, the majority of additionality is through increasing the scale of benefits, or bringing forward the timing of benefits. The greatest percentage of respondents (54%) say they would have achieved a significantly smaller range of benefits, at a reduced scale, and it would have taken longer to achieve them. A further 31% report more limited benefits.

Examining evidence from the survey of beneficiaries, in general terms, evidence for attributable employment benefits is low. Estimates of employment additionality (that is, the difference support has made over and above what would have happened anyway) are low for all years. This is the case whether employment multipliers are used or not. While the figures are based on a very small sample (from 27 responses), it may not be expected that large employment benefits would be realised: very few Phase one projects scaled, a relatively small pool of industry partners are engaged in more intensive activities such as collaborative projects, and these projects are primarily aimed at achieving wider benefits. The nature of the interventions, involving relatively low-intensity interventions in some cases, or focused on projects that are often not primarily commercial in nature, does not easily translate into attributable employment benefits.

The employment benefits identified are associated with increased economic benefits in terms of Gross Value Added (GVA). Cumulative net additional GVA of £1.5 million (at constant prices) for the period 2012- 2022 is estimated. It is emphasised that the reported results relate to a relatively sample of IC beneficiaries and that the grossed up figures presented are indicative. A much wider analysis would be required to assess the true economic impact of these interventions (i.e., valuing the health, transport benefits through, for example, improvements in expected lifetime earnings, service cost savings, and reduced journey times).

5.2.3 Wider impacts including health and societal impacts.

As discussed above, the primary focus of DHI is on societal challenges across healthcare via digital tools and services where there are tangible benefits for health and well-being, leading to number of broad outcomes/impacts, including:

- An acceleration of digital innovation and adoption into health & care.

[11] Ekos (2016) Business engagement and economic impact evaluation of the Innovation Centres Programme, report to the Scottish Funding Council, Ekos: Glasgow.

- Digital interventions empower citizens and create service capacity.
- Effective data exchange takes place between consumer & public systems, supporting integrated and preventative care.
- Digital innovation is embraced by the workforce as a fundamental component of 21st century health and care delivery.
- Scotland attracts greater digital investment.
- The Scottish population has greater choice and control of the way they interact digitally.

Discussion with stakeholders indicates that DHI activities are leading to improved service delivery with broader health and societal benefits {35, 36 38]. As such, DHI's project activity relates to key health challenges across a wide number of themes including: cardiovascular; demand and capacity management, diabetes, cancer, chronic respiratory, digital skills, healthy ageing, citizen empowerment and mental health.

For example, completed projects include:

- NHS Greater Glasgow and Clyde Diagnostics- in 2019, NHS Greater Glasgow and Clyde (GGC) commissioned the DHI Insights Team to support the co-design of innovations and improvements in three clinical areas: Gastroenterology, Trauma and Orthopaedics. The findings from the work will form the basis of speciality-led programs delivering solutions to help care services in GGC to sustainably meet the challenges of the future.
- Community Mental Health and Wellbeing- the Scottish Government commissioned the DHI to conduct research into the current landscape to identify key themes for future focus and to support the establishment of a national Mental Health Collaborative.
- Type 2 Diabetes Framework - DHI co-produced a national framework to prevent, detect and improve outcomes for type 2 diabetes. The framework was developed to provide guidance to delivery partners on the implementation of a specific weight management pathway for those 'at risk' or those diagnosed with type 2 diabetes.
- FUTUREquipped - a project preparing Scotland's workforce to respond to the digital and technical revolution. Twenty-seven lecturers from thirteen colleges across three disciplines participated in the project and, through this medium, participants were introduced to the latest developments in digitally enabled health and care and construction practices. They were then asked to collaboratively develop new teaching modules to integrate learnings from this pilot into respective college courses.
- As well as SCOTCAP, which is discussed further in the case studies below. During 2020/21 DHI successfully enabled the large-scale evaluation and design of a scalable national service model for Colon Capsule Endoscopy (CCE) through the SCOTCAP project.

In particular, it has been noted above how the wider impacts of DHI's activities in relation to the Covid-19 pandemic, where the IC pivoted their approach to help address Scotland's response and where DHI became a fundamental part of the Scottish Government's national response to the Covid-19 pandemic. The case studies below also provide further insights in to the nature of wider impacts derived from DHI activities.

In considering the wider benefits of DHI support, clients were asked which, if any, of the UN Sustainable Development Goals (SDGs), their establishment had made a significant contribution to, as a result of working with the Innovation Centre. **Some 77% of client survey respondents referenced a significant DHI contribution to attainment of wider benefits.** A wide range of benefits are cited, particularly in relation to:

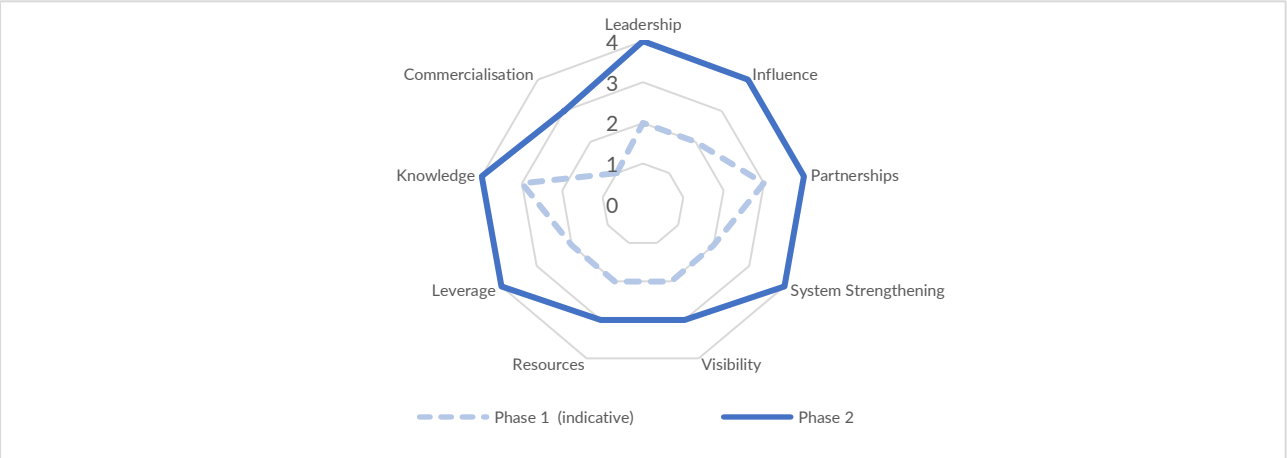
- Good health and well-being (e.g., ensuring healthy lives, promoting wellbeing, COVID response) (40%).
- Industry, innovation and infrastructure (e.g., adoption of new medium-high, and high technologies) (30%).

- Reduced inequalities (e.g., supporting disadvantaged groups or regions) (23%).
- Quality education (e.g., promoting lifelong learning and access to education) (10%).

5.3 Assessment of innovation ecosystem benefits.

The evaluation objectives include an assessment of how effective each IC has been in building engagement in its own ecosystem. The approach to assessing the role of ICs within the wider innovation ecosystem is set out in Appendix A, and summarised for DHI in Figure A. 2 (authors' scoring). Less evidence is available for a detailed assessment ecosystem benefits at the end of Phase 1. However, an indicative rating is noted for Phase 1 based on a review of DHI's programme documentation, stakeholder consultations, and client feedback.

Figure A. 2 DHI Innovation Ecosystem Benefits.



Source: authors

System Leadership

Based on this framework, Phase 2 has witnessed a strong performance from DHI in relation to leadership, influence and partnerships.

Leadership

- It is evident from discussion with stakeholders (and wider analysis) that DHI has played a prominent role in providing strategic leadership and acting as a catalyst via development of sector/ technology area strategies, including articulating and communicating development needs, identifying opportunities and solutions to partners and stakeholders (particularly in relation to the NHS).
- For example, DHI is represented on a range of groups including the Scottish Government Digital Health & Care Citizen Board, UKRI Healthy Ageing Grand Challenge and UK5G Advisory Board. They have also supported the National Care Service's international landscape review and chaired the Scottish Life Sciences Industry Leadership subgroup on Digital and Data.
- To a significant extent, clients also identify DHI as a source of industrial leadership. When questioned directly, some 47% of DHI clients stated that DHI had been a significant source of support for the wider innovation ecosystem in terms of providing strategic leadership for the sector or technology area. In addition, 53% of DHI clients stated that DHI had been a significant source of support for their establishment in terms of acting as a source of sector or technology expertise.

Influence

- Similarly, there are multiple examples of influence where DHI informs and influences strategy and actions related to the sector, including defining the distinctive roles of partners, getting partners to commit to shared strategic objectives and influencing partners to allocate funds. As noted above, DHI is represented on a range of sector groups.
    - DHI commissions and administers academic research grants directly and on behalf of key partners. In 2021/22 DHI co-funded an academic call to evaluate the 'Connecting Scotland's Care Home Residents' programme (£65K) in partnership with the SG Digital Health & Care Division.
    - For example, these included some nine small awards, three medium and two large awards over the period 2021/22.
- To a significant extent clients also assert a positive influencing role for DHI. Questioned directly, 47% of DHI clients stated that DHI had been a significant source of support for the wider innovation ecosystem in terms of effective policy or strategic influence.
- DHI point to an influencing role in establishing digital health and care as core components in college courses[12], a view supported by the (limited) consultations with college stakeholders for this report [32].

Partnerships

- Looking at the dimension of partnerships, there is a range of evidence indicating the effective role of DHI as a strategic partner through the development of new strategic partnerships and in particular facilitating the sharing of approaches leading to the identification of collaborative opportunities and the diffusion of good industry practices. For example,
    - DHI is working with the SG's Digital Health and Care & Innovation Directorate, the SG Diabetes Group and the Scottish Health and Industry Partnership (SHIP) sponsored by the Chief Scientist's Office to accelerate Digital Diabetes Innovation Opportunities.
    - DHI progressed a rapid discovery and simulation project in partnership with the CfSD to develop a 'high level' current state map dermatology service in 10 NHS Scotland Health Boards.
    - Digital Lifelines Scotland is a SG priority programme which seeks to help overcome digital exclusion and design new digital solutions with and for people with multiple and complex needs at increased risk of drug related harm. DHI is working with key partners on the Discover and Define phases of the programme.
    - DHI supported the NHS in its recovery by informing requirements for a new digital volunteering system. Discussions are now progressing with NHS Health Improvement Scotland (HIS) and key stakeholders on next steps.
    - Dynamic Scot: This project commenced in July 2020 in partnership with NHS Greater Glasgow and Clyde (NHSGGC), NHS National Services Scotland (NSS) and Storm ID (Scottish SME). Building on an Innovate UK funded initiative which developed a web-based application to support people with Chronic Obstructive Pulmonary Disease (COPD) to self-manage at home with support from clinicians and tools for self-management.
    - In the areas of skills, DHI have built strategic partnerships with the newly established NES Digitally Enabled Workforce programme, NHS Skills Academy and South of Scotland Digital Skills Hub, as well as strengthened collaborative activities with colleges and universities to influence curricula for the digital health and care workforce, and

[12] DHI correspondence March 2023.

health and care workforce coming out of FE and HE (e.g., working with Glasgow College).

- A strong indication of partnership is the number of collaborative projects. The MEF indicates some 17 collaborative projects in Phase 1 and a further 25 in Phase 2 (underway or completed), and a further four in the pipeline. In Phase 2, 12 of these projects involved at least one business in Scotland (data not available for Phase 1).
- As noted above, the client survey respondents confirmed a high level of collaborative project involvement (63% with more than one partner, 60% with one partner), often sustained over multiple rounds of IC support (23% accessed four or more rounds). Some 37% of DHI clients also report improved cross-industry collaboration.
- Questioned directly, some 60% of DHI clients stated that DHI had been a significant source of support for the wider innovation ecosystem in terms of acting as a strategic partner e.g., developing or sustaining new strategic or longer-term partnerships. In addition, 53% of DHI clients stated that DHI had been a significant source of support for their establishment in terms of supporting the development of trust between their organisation and other organisations in their sector/technology area. Some 20% of clients indicated a joint venture with an academic institution, and 33% with business.
- It was also noted above that DHI survey beneficiaries have often engaged in partnership with other ICs, particularly The Data Lab, CENSIS, IBioIC, and PMS-IC.
- International partnerships include strategic partnerships with Kaiser Permanente, Saudi Arabia, The Gates Foundation, and European Interreg projects with ECHAlliance, NWE.CHANCE, ACSELL and TITTAN; and national collaborations with Ireland, Nordics (Finland and Norway), the Middle East and Australia.
- Also, DHI note that they have worked with 70% of universities in Scotland and over 60% of colleges since their establishment[10].

System strengthening

- DHI demonstrates a number of outcomes associated with the creation of synergies, including the development of a collaborative culture, primarily public sector-industry, but with an important academic contribution through facilitation and commissioned support. A core feature of much DHI work has been explicitly focused on creating cross-sectoral connections, improved dialogue between partners, and enhanced practices for identifying and developing innovative solutions for service delivery improvement. This work also goes in tandem with the setting up of mechanisms and incentives for more effective and deliberative engagement of stakeholders in the design and delivery of local priorities and projects.
- A good example of system strengthening in terms of digital solutions in health and care settings is the centre's work around COVID (discussed in more detail above) given the work across the health system to respond rapidly through design, to testing and implementation.
- The survey of DHI clients also demonstrates a positive contribution to a collaborative culture with DHI playing a significant role in developing client relationships with a wide range of bodies relevant to the innovation ecosystem, e.g., 40% of respondents indicate DHI has significantly supported clients to developed better relationships with other clients or customers from the public sector, and 33% with universities or colleges.
- The MEF and other evidence suggests DHI has been successful in facilitating cross sectoral connections with some 1,332 DHI innovation cluster members recorded as of July 2022 (with 6,650 delegate numbers participating in 15 DHI led events and 18 partner led events). In particular the client survey indicates a range of networking benefits to DHI clients, with for

example 33% of clients pointing to new business, and public sector contacts, and 23% to new academic contacts.

  - For example, the Healthy Ageing Innovation Cluster (HAIC) has held five events in 2022 attended by over 200 members. Cluster membership has also grown by 28% in 2022. HAIC also hosted the UKRI Designed for Ageing Challenge 2021 Call. The Digital Mental Health Innovation Cluster (DMHIC) was also launched in March 2022.

- In terms of creating linkages between partners, some 52 instances of signposting have been recorded over phases one and two (28% to enterprise agencies, 63% to other public sector (including NHS), and 8% to the private sector).
- When asked directly, some 50% of DHI clients stated that DHI had been a significant source of support for the wider innovation ecosystem in terms of fostering synergies and networking within their sector or technology area. The survey of DHI clients also pointed to engagement with a wide range of higher education institutions, particularly Glasgow School of Art and the University of Glasgow. However, engagement was limited with colleges in terms of range of institutions and number of collaborations.

System Resources

Visibility

- Visibility is also positive, with multiple examples of advocating the needs of the sector, regionally, nationally and internationally, as well as engaging in a wide range of international R&D projects. DHI note participation in over 100 local, national and international events. DHI notes it significantly exceeded its planned programme of events in 2022, including 18 partner events, 49 speaker slots including 13 international slots. For example,
  - DHI delivered two virtual Global Digital Health Summits with their partner Kaiser Permanente and engaged a select global audience (circa 50 people from US, Scotland, Ireland, Sri Lanka, Singapore and the Commonwealth) on the Application of Predictive Analytics and Care in Place.
  - In February 2022, DHI partnered with University of Edinburgh, the Danish Centre of Excellence, NHS Highland and Strathclyde University in a successful submission to Horizon Europe on “AI Supported Image Analysis in Large Bowel Camera Capsule Endoscopy (AICE)”.
- Clients have a positive view on DHI’s impact on sector visibility at the national level. When questioned directly, some 60% of DHI clients stated that DHI had been a significant source of support for the wider innovation ecosystem in terms of in terms of raising the profile of the sector/technology area within Scotland. Further, 57% of DHI clients stated that DHI had been a significant source of support for their establishment in terms of supporting improved visibility within sector/ technology area.
- Undoubtedly DHI led events have played a key role in this regard, with 95 events (<100 attendees) as at Phase 2, year three, and 43 events of greater than 100 attendees. In addition, there have been some 15 market and research reports published by DHI, and six other publications.
- Client perceptions of the role of DHI in enhancing visibility at the international level is also evident. Some 37% of DHI clients stated that DHI had been a significant source of support for the wider innovation ecosystem in terms of raising the profile of the sector/technology area internationally.

Resources

- In terms of resources[13] DHI continues to develop the DHI Exchange (a physical and virtual environment to help drive knowledge exchange around digital health and care innovation), and explore opportunities to commercialise it for the benefit of Scotland. DHI note that SDI recognise the DHI Exchange as one of Scotland's key national assets and an anchor product for digital health when they are promoting Scotland through their international networks[14] (see case study below).
- In addition, DHI has demonstrated the applicability of their design thinking as an innovation process, across multiple projects nationally and, through the work of GSA, has held discussions with other ICs (in particular BE-ST) on adapting these approaches to other sectors.
- In this regard, some 43% of DHI clients stated that DHI had been a significant source of support for their establishment in terms of supporting the sharing of common resources.
- It is noted that DHI have recently received grant funding from SE towards the employment of a senior business innovation manager, to develop and deliver approaches to increasing industrial engagement and collaboration projects.

Leverage

- With regards to leverage, as discussed above, DHI has proved very effective during the course of Phase 1 and 2 at meeting the relevant criteria, including securing Scottish and other UK public sector research funding, supporting applications for funding, and attracting new investment to Scotland. DHI has exceeded its full life target for external funding (£3 million), with a Phase 2, year three achievement of £8.4 million. It is noted that the Rural Centre of Excellence in Digital Health and Care Innovation received £5 million from the UK Government (2022).
- On the basis examined in section 6.33 below, DHI has mobilised some £15.9 million over Phase 1 and 2.
- Leverage of external funding has been successfully achieved (focused on a relatively small pool of large projects), and with significant contributions from other public sector partners. This may go some way to explaining the moderate perception of leverage by the wider client base.
- Questioned directly, some 30% of DHI clients stated that DHI had been a significant source of support for the wider innovation ecosystem in terms of promoting investment and leverage of resources into the sector/ technology area from within Scotland. In addition, 23% of DHI clients stated that DHI had been a significant source of support for the wider innovation ecosystem in terms of promoting investment and leverage of resources into the sector/ technology area from outside Scotland.

Knowledge

- Considering DHI's contribution to how knowledge is created and spread between actors and combined or applied within the system, the maintenance of a positive contribution on the knowledge dimension is evident in the extensive market research and publication record of the centre (in addition to the DHI Exchange), primarily for a Scottish and UK audience, but with increasing international reach. For example, DHI also supports the creation of a talent pipeline by raising the profile of digital health and care career opportunities and influencing the curricula in Scottish Schools, Colleges and Universities and supporting partners to create learning options, including working with partners to develop Clinical Innovation and Entrepreneurial fellowships and further online learning through updated Massive Open Online Courses (MOOCs) and continuing professional development (CPD) modules.

[13] Defined as development of physical research and innovation infrastructure and environments or Improved organisational capacities or ways of working (innovation processes).
[14] DHI (2021) DHI's response to Covid-19 pandemic emergency years (2020/2022), DHI: Glasgow, p.14.

- The maintenance of a positive contribution on the knowledge dimension is also evident, for example in the master's and Ph.D. programme, as well as a range of wider skills development initiatives. Some 80 M.Sc. students, and four Ph.D. students gaining new qualifications/skills are recorded as at Phase 2, year three, along with four HNC/HND level students and 5,889 other course participants. It is also noted that 12 new higher education posts were created in Phase 2 (Phase 1 not recorded). No new posts were created in colleges.
- As noted, DHI commissions and administers academic research grants directly and on behalf of key partners. In 2022 DHI co-funded an academic call to evaluate the 'Connecting Scotland's Care Home Residents' programme (£65K) in partnership with the SG Digital Health & Care Division. A further three awards are progressing, with University of West of Scotland, University of Strathclyde and University of St Andrews.
- DHI note some 240 reports published by them (including 15 in 2022) (with approximately 5,000 report downloads), along with six publications in journals. This signifies very good example of knowledge exchange, used to inform sector and project development.
    - Some 193 DHI produced outputs are hosted by the University of Strathclyde Open Access Repository.
    - The most accessed report is the Review of Emerging Trends in Digital Health and Care report, with 2,815 downloads, followed by Spotlight on Careers in Digital Health and Care (1,835). In 2021/22, the most downloaded item was the Spotlight report with 795 new downloads, followed by Emerging Trends in DH&C (421).
- A range of knowledge benefits are identified by DHI clients, as discussed above, for example, 47% indicate improved technical understanding of priority technology areas in their sector. In addition, some 37% of DHI clients stated that DHI had been a significant source of support for the wider innovation ecosystem in terms of in terms of supporting knowledge development and dissemination (e.g., new courses, university or college networks, attraction of talent). Further, 53% of DHI clients stated that DHI had been a significant source of support for their establishment in terms of supporting diffusion of knowledge and good practices.

Commercialisation

- Given DHI focus, the scale to which this has occurred with commercial exploitation by businesses is moderate in terms of number of cases (30 in total over phases one and two). However, the MEF does not record anticipated jobs supported/created or anticipated turnover supported/ created.
- In terms of supporting activities leading to public sector exploitation, it is acknowledged that DHI has been successful in the fostering of innovation processes leading to public sector exploitation, by virtue of the model adopted by DHI in Phase 2. Some 12 instances of adoption and scaling were reported, representing a significant achievement by virtue of their reach at national level.
- The client survey also demonstrates a moderate range of innovation investment by DHI clients, with, for example, half of client respondents engaged in design activity of some form (in eight out of 15 cases the clients indicate DHI played a significant role in this activity).
- Just under half of those surveyed carried out internal R&D since they started working with the IC (in eight out of 14 cases the clients indicates DHI played a significant role in this activity. As noted elsewhere, some 40% of DHI clients have introduced new or significantly improved services since they started working with the IC and one in five (20%) new or improved goods. A further 17% had introduced new processes. Where these have occurred, DHI has typically played a significant role i.e., 10 out of 12 cases, five out of six cases and four of five cases respectively. No start-ups or spin outs were recorded.

- The fostering of new technologies and experimentation with clients is also evidenced by a strong contribution to the advancement of project TRLs, with 72% of clients stating that DHI was 'very' or 'extremely important' in advancing their project TRL.
- In addition, some 40% of DHI clients stated that DHI had been a significant source of support for the wider innovation ecosystem in terms of encouraging experimentation and commercialisation in Scotland (e.g., start-ups, spin-outs, testing of new technologies, demonstrating new technology or processes).

6 Delivery and value for money.

6.1 Governance and operational arrangements.

DHI was established in 2014 as a collaboration between the University of Edinburgh and The Glasgow School of Art, supported by NHS 24. In 2016, the University of Strathclyde took over the position of hosting institution from the University of Edinburgh (this was also associated with a change in strategic approach for the centre, as discussed above, and a degree of disruption during the transition phase [61]). Both the University of Strathclyde and GSA retain positions on the DHI Board. A Strategic Advisory Group (SAG) and Commercial Advisory Network (CAN) have been established to provide advice, insights and an external perspective on key areas of work, with reports provided to the Board.

The DHI host institution is the University of Strathclyde, with the Glasgow School of Art as a collaborative partner. The relationship between the University of Strathclyde and the Glasgow School of Art is set out in a collaboration agreement which documents how funds transfer between the two institutions to cover the salary costs and overheads of the Design Research team. The governance responsibilities for DHI sit exclusively with the University of Strathclyde as its host.

The DHI executive team comprises CEO, Director of Innovation, Director of Panning & Performance, and Chief Technology Officer, with additional skills and expertise supplemented by the wider Senior Management Team. At the time of writing there were 42 staff (with 7.4 FTES hosted by GSA) [Host University representative 41].

Stakeholders noted challenges in recruitment and retention (a common theme across ICs), with host university and ICs working to resolve personnel structures, and resourcing of posts at competitive salaries, but with the process taking longer than ideal [Host and Board representatives 18, 12]. In addition, one host university representative pointed to a desire to see funding arrangements that permitted a greater degree of career planning, rather than recruitment to short term project-related posts [41].

Host university relations at the current time are generally regarded as very positive (in terms of governance and strategic fit) by both host and centre, notwithstanding recruitment and retention challenges noted [27, 18]. It was noted that it would be beneficial for the programme to have national guidance for host universities on adopting sufficiently flexible staffing and financial governance arrangements to accommodate the distinct needs of ICs [18]. However, any difficulties in university-IC hosting arrangements were generally viewed to be surmountable and to outweigh the governance risks of a more fully autonomous organisational arrangement for the IC [DHI senior management and board members 27, 57].

There are very good satisfaction levels with DHI support across the board, although number of responses for individual ICs is low, notably :

- 100% satisfaction with IC conferences and events.
- 100% satisfaction with post-graduate placements.
- 100% satisfaction with advice and signposting.
- 100% satisfaction with training and development support.
- 100% satisfaction with lab, test or demonstration facilities.

- 100% satisfaction with consultancy support projects.
- 94% satisfaction with collaborative project support (one partner).

Marginally lower levels of satisfaction (although still very high):

- 86% satisfaction with support for a consultation process.
- 83% satisfaction with collaborative project support (more than one partner).
- 50% satisfaction with IC membership (paid or free).

6.2 Monitoring and evaluation.

Throughout DHI's funding, SFC has received quarterly progress reports, and monitoring data was readily available. DHI continued with the application of a comprehensive framework of quantitative metrics allow both internal and external stakeholders regular KPI updates at appropriate levels of detail.

However, given the shift of emphasis of approach of DHI, it is evident that the current programme MEF does not capture the broader health and public service impacts of DHI projects: the MEF has not kept up with the evolving logic model of DHI and correspondingly needs revisited. Neither does DHI report on a supplementary set of indicators that capture this activity. Reporting of these significant wider benefits is qualitative in nature at this time and the programme MEF would benefit from revision to capture wider benefits though the identification of appropriate qualitative and quantitative indicators and appropriate targets.

6.3 Value for money.

This section of the report sets out the main findings of the evaluation with regard to value for money.

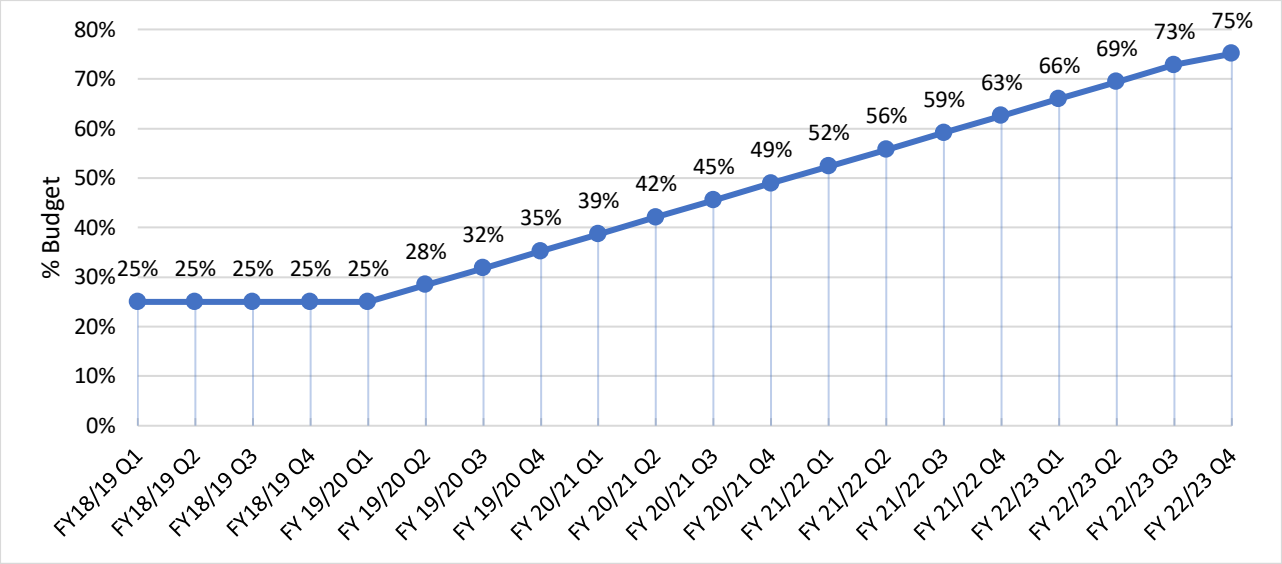
6.3.1 Limitations.

The overall programme MEF provides a limited framework of quantitative metrics that can be used to assess VfM. The main body of the report discusses the limitations in greater detail. This report uses the latest financial data available, i.e., to Dec 2023 and /or March 2023.

6.3.2 Budget execution.

Total Phase 1 spend is as £23.4 million. Funder budget drawdown is used as a proxy for expenditure. Phase 2 budget execution is noted in the table below. Quarterly drawdown is approximate. Some 75% of the funder budget has been drawn down for the period up to March 2023 with IC spend on track for the remainder of Phase 2 (assumes SG H&SC contribution awarded at outset).

Table A. 10 DHI budget execution.



*Source: SFC, SE, HIE correspondence ('Summary funders awards and drawdowns to date', excel spreadsheet, Feb 2023). * funders indicate awarded at outset of Phase 2.*

6.3.3 Finance mobilised.

Finance mobilised (public or private) is not recorded as a specific MEF indicator. Here, it is assessed as all recorded MEF commitments (project and centre combined), excluding all funder commitments. MEF commitments are presented as supplied by the IC.

On this basis, some £15.9 million was mobilised over Phases 1 and 2. Of this, the great majority (99%) was public sector funds. Comparing funder inputs (to Jun 2022) to finance mobilised, this indicates an estimated leverage of £18.4 million to £15.9 million, or 0.7:1 (benefit to cost ratio) (see table below).

As noted, projects are delivered via a number of funding mechanisms:

- Core funded (Core) – Defined as funds exclusively allocated from the DHI core budget.
- Joint funded (Joint)– Defined as a mixture of DHI core (in-kind) and additional funding contributions.
- Additional funded (Add) – Defined as commissioned and leveraged additional funding.

As of 2022, the majority of active projects were joint funded with a further two additional funded and no core funded projects. For live additionally funded projects as at end July 2022, the funders and awards are noted in Table A. 12.

Table A. 11 Finance mobilised, DHI, to Jun 2021/22

	Phase 1	Phase 2	Total
Higher Education Institutes	£43,575	£25,800	£69,375
Other Public	£2,083,658	£13,491,790	£15,575,448
Industry	£32,559	£197,000	£229,559
Other	£-	£26,400	£26,400
Total	**£2,159,792**	**£13,740,990**	**£15,900,782**

Source: MEF.

Table A. 12 Additionally funded projects, July 2022

Funder	Award (£)
Macmillan	45,000
Scottish Government	2,469,365
Scottish Government,	573,246
SLIC	7,000
Scottish Government Digital H&C	243,000
Scottish Government Digital H&C	50,000
Scottish Government	220,000
Scottish Government	131,621
Midlothian Health and Social Care Partners	163,317
Moray Council*	5,000,000
Scottish Government Digital H&C	60,000
Scottish Government Digital H&C	37,500
Scottish Government,	77,040
Scottish Government,	50,000
Scottish Government,	51,100
Scottish Government,	50,000
Scottish Enterprise	209,000
Scottish Government,	8,907.6
Scottish Enterprise	17,500
Interreg NWE	87,847
Total	**9,551,443.6**

*Source: DHI. * The £5m funding is administered by Moray Council on behalf of UK Government as part of the Moray Regional Growth Deal*[15].

6.3.4 Cost per impact measure.

It is important that value for money assessments consider programme effectiveness, that is, the relationship between the intended and actual results of public spending. In other words, what are the higher-level outcomes / impact of the programme and at what cost. In this regards, two impact measures are generally examined across ICs: jobs and GVA. It is acknowledged that all ICs to a greater or lesser extent, have a focus on wider environmental, health, social benefits, and therefore these impact measure do not capture all of the benefits of ICs. In the case of DHI, given the very low jobs and GVA measures identified and that these impacts are not aligned with DHI MEF measures, we have not included these estimates here.

6.3.5 Equity.

While based on a small sample, the client survey pointed to a preponderance of central belt clients (predominantly Glasgow and Edinburgh based establishments), with a lower representation in the HIE area (3%) and a further 3% in the Borders. Broadly speaking the survey client employment size band reflects network membership, with 93% SMEs, and 7% large employers (250+).

As noted above, DHI records that some 45% of student scholarships have gone to the University of Strathclyde, 19% to Stirling, 8% to Edinburgh, 7% to GSA. Therefore, there appears scope to maximise the value of a wider range of universities in Scotland in this regard.

Moray Rural Centre of Excellence (RCE): It is noted that this programme launched in 2022 will create a dynamic digital health and care ecosystem in a rural area within the HIE geography, sustaining public services; inclusive growth through job creation and skills development; accessible services and will contribute to the UK's Net Zero ambitions. This programme represents a £5 million capital investment from the UK Government, delivered by the DHI over 45 months, to support the remobilisation and sustainability of health and care services in Moray.

[15] DHI correspondence March 2023.

7 Progress against targets and objectives.

7.1 Targets.

DHI progress against core performance targets is noted below in Table A. 13, and demonstrate positive progress against 2024 targets for most measures. Nine are exceeded, two are on track, and four are off track (under 75% achieved). In particular, innovation cluster participants, event delegate numbers, Scottish Government projects readied for adoption, external funding leveraged, and publications have all exceeded targets by a large margin.

Number of challenge competitions hosted, academic grant awards, market research reports, and work experience placements were significantly below target as at the reporting date of July 2022.

Table A. 13 DHI core performance targets.

Performance Targets	Actuals July 2022	Year 5 Target 2024	Actuals (% of Totals by 2024)
1. Innovation Cluster			
IC1.1- DHI Total innovation cluster numbers by 2024	1,332	1,200	111%
IC1.2- Number of events led (workshops, seminars.)	49	20	245%
IC1.3- Number of events partnered	37	20	185%
IC1.4- Estimated delegate numbers reached	11,767	2,400	490%
IC1.5- Number of intros/signposting from cluster	32	35	91%
IC1.6- No challenge competitions hosted	1	3	33%
2. Project Portfolio			
PP2.1- No. of SG core funded projects	4	10	300%
PP2.1a- No. of joint funded projects	*17*	-	-
PP2.1b- No. of additionally funded projects	*9*	-	-
PP2.2- SG project ready for adoption	12	2	600%
PP2.3- Academic Grants	c£148k	£250k	59%
PP2.4- Secure additional funding (target) - (i.e., 2.4a Public- 2.4b - comm)	£11.7m*	£3.0m	390%
3. Skills development & knowledge exchange			
SDKE5.1- Market & Research reports	52	70	74%
SDKE5.2- Publications	12	5	240%
SDKE5.3- Work experience placements	4	10	40%
SDKE5.4- Master scholarships	67	N/A	**-
4. Demonstration & Simulation environment			
DSE4.1- DSE asset dev (cap ex)	£339k	£400k	85%
DSE4.2- No. of digital transferable solutions (showcased)	14	10	140%

Source: DHI Target tracker for Phase 2 (2019-2024). *£2.56m included phase 1b funding of approx. £800m – for clarity this figure has been deducted from the overall total to reflect the Phase 2 period. **Master's scholarships (FTE) did not have an associated target from SFC but work on the basis or approximately 20 scholarship awards per annum.*

7.2 Objectives.

As outlined in the main report, the authors' identified 10 objectives at programme level, taking the objectives set out in the Phase 1 Call for Proposals and Phase 2 Business Planning guidance as a starting point. The table below explores DHI's focus on these 10 programme/evaluation objectives (see Table A. 14).

Table A. 14 DHI achievements against objectives

Objectives and strength of focus		Explanation of rating
O1: Direct businesses to support	Moderate	MEF and survey evidence demonstrates moderate levels of signposting sources of support. Stakeholders indicate that the team routinely refers businesses that make enquiries to other sources of support. The increasing expansion of cluster activity also makes a strongly positive contribution to this objective.
O2: Build and promote ecosystems & sectors	High	DHI is active actively engaged at a strategic level with a wide range of sector stakeholders. As noted, networking clusters have also been established and are being further developed. Hosting and attendance at a range of national and international sector fora builds and promotes visibility of the sector. The MEF records the number of engagement events delivered by DHI. In Phase 2 to date nine large events and 47 smaller events have been delivered.
O3: Drive business growth	Low	The 'low' rating is primarily a function of strategic orientation of DHI from Phase 1b, and the strong focus on public sector innovation. This programme objective is less relevant to DHI given the agreed areas of focus with funders. The MEF does not record new jobs created and existing jobs safeguarded in businesses, or increased turnover, and client survey findings do not identify substantial employment benefits or associated GVA.
O4: Win external funding	High	The MEF highlighted how DHI have significantly exceeded targets in securing funding. Several stakeholders highlighted the recent successful Moray Growth Deal bid as an example of a funding bid that was enhanced through DHI's involvement. However, private funding leveraged is relatively low, and demonstrates that there is scope to leverage a higher degree of industry finance in tackling the challenges in digital health and social care.
O5: Solve industry problems	High	This objective encourages Centres to exploit academic research to solve industry-defined problems. The shift in strategy by DHI during the course of Phase 1b and Phase 2 has focused the work of the centre more directly on the challenges identified in dialogue with the SGHCD. Stakeholders highlighted that DHI is highly effective at leveraging academic expertise to support the public sector, and is a highly effective intermediary and convening body.
O6: Address major policy priorities	High	Stakeholders highlighted that during Phase 1b and 2 DHI has demonstrated close alignment with the Scottish Government's major policy priorities in the area of digital health and social care, as well as successfully pivoting to support national level priorities during the COVID pandemic.
O7: Secure inward investment	Low	The MEF doesn't record number of businesses assisted to relocate or establish new facilities in Scotland. Stakeholders did not highlight inward investment as an area that they see DHI delivering on strongly. Interviews with staff did include reference to relevant work, and highlighted that in promoting the ecosystem with international partnerships and events, the Centre is raising Scotland's profile internationally. Again, a low rating is partly a function of the strategic orientation of DHI from Phase 1b, with the strong focus on public sector innovation.
O8: Enhance public services	High	The MEF records a substantial number of collaborative projects leading to new or improved delivery of public services. DHI reported 12 such projects to date, with a number of national level contributions to service design, testing and implementation. Stakeholders also identified multiple examples of DHI partnership work that has led to new or improved public services.
O9: Develop skills	Moderate	The MEF records the number of people gaining new qualifications. To date DHI supported 80 MSc and four PhDs (a comparatively low number of master's in comparison with other ICs). However, a very significant further 5,903 individuals have gained other CPD qualifications or skills. Stakeholders also commented on a moderate contribution to skills development within the sector, relative to need. Therefore,
O10: Develop next generation	Moderate	The tenth objective encourages Centres to '*grow an environment to develop the next generation of business innovators, academics and entrepreneurs.*' The MEF does not include any measures that enable us to assess DHI's focus on this objective. Other evidence identifies a range of specific activities that help promote the sector including curriculum development and the international, youth focused DigiInventors Challenge. Again, a moderate rating is partly a function of the strategic orientation of DHI from Phase 1b, with the strong focus on longer term, demand-led public sector innovation relative to more supply-led commercialisation initiatives.

Source: authors

8 Impact case studies.

8.1 Introduction.

The section present the findings from a number of case studies linked to the work of DHI in order to provide a more an in-depth and comprehensive understanding of selected projects and to gain an understanding of why, for whom and under what circumstances the IC achieves its Objectives.

8.2 Case 1. SCOTCAP.

The Scottish Capsule Programme (SCOTCAP) is a service, technical and business transformation programme to support the national scale up of Colon Capsule Endoscopy (CCE) as a gastrointestinal (GI) Diagnostic Test in Scotland. The programme is an integral part of the national redesign of outpatient gastroenterology services as it enables early and effective screening in the community, avoiding unnecessary referrals for hospital outpatient appointments.

Context

CCE is a procedure which involves swallowing a capsule the size of a vitamin pill. The capsule contains a digital camera which is swallowed and, on its journey, takes up to 400,000 images (32 per second), which are remotely reviewed and analysed. It is highly accurate, with the potential to be cost effective, less invasive, and more acceptable to patients, than existing procedures. It is not currently routinely used in Scotland for large bowel investigations and could potentially be a viable and safe alternative to traditional colonoscopy.

Collaborative project work

Fundamental to the success of this work was to bring together like-minded innovation partners from across sectors to drive forward the testing and evaluation of an Innovative Service Model Using Colon Capsule Endoscopy (CCE) in a real-world setting. The DHI Design Team was led by Design Researchers from the Glasgow School of Art (GSA), Innovation School. In this project the Design Team employed a design-led, co-production approach. They carried out a series of interviews and service evaluation workshops with professionals involved in endoscopy services, in order to capture insights about the evolution of the SCOTCAP service model during the Innovation Phase. The insights gathered included challenges and opportunities identified by each of the participating NHS Health Boards, areas for further improvement, and recommendations on how to achieve the 'ideal and scalable SCOTCAP service model'. These insights supported the development of their key recommendations to enable the SCOTCAP service model to operate nationally at scale. Industry partners included Medtronic (a multinational healthcare technology firm) and CorporateHealth International (a Danish headquartered multinational start-up with a main UK office in Inverness).

Benefits

During 2020/21 DHI successfully enabled the large-scale evaluation and design of a scalable national service model for CCE through the SCOTCAP project. During June-Dec 2019 a total of 317 patients experienced the new CCE pathway in the three NHS health boards (Highland, Grampian and Western Isles).

University of Strathclyde's evaluation revealed that clinicians and decision makers believe there are real benefits to:

- The patient (e.g., less invasive procedure, less travel).
- To the existing clinical pathway (e.g., reducing waiting times).

Patients reported that they could see value in CCE and there were no reported difficulties in swallowing the capsule. When asked if they would recommend this service to others most patients (162/195) responded that they would. Patient data also indicated several areas for continued

improvement to the service including: the need to continually improve the comfort and wearability of the technology (e.g., the belt); the transparency of the new service and process (for example communicating anticipated timelines, and managing expectations around the bowel preparation).

Implementation findings revealed several significant areas that others should address if implementing this (or similar) new innovative services. These included the need for: more agile health innovation project management strategies; resolving issues around data sharing and information governance; implementing supporting IT systems; innovative partnership working to accelerate service transformation; embedded service evaluation frameworks.

One of the unique business innovation aspects of the programme was the creation of Scotland's first **Innovation Partnership procurement contract** across NHS Scotland. This has enabled commissioning bodies to 'partner' and work collaboratively with private sector companies to both develop and test a new service within the community.

Significantly, these services could be rolled out across Scotland without the need for a further procurement if the evaluation proved successful. In addition, this project tested and refined the business model working with the industry partner to create a successful managed service and secure further inward investment and economic development in the North of Scotland.

It is also noted that the project is associated with significant expansion of employment at the Inverness base of industry partners, CorporateHealth.

Next steps

National roll out of CCE is well underway in NHS Scotland under the leadership of the Centre for Sustainable Delivery (CfSD) and is actively contributing to the reduction of waiting times for Bowel Cancer Diagnosis. DHI is exploring and evaluating opportunities to iterate the service further, co-ordinating an innovation pipeline to support next generation service redesign and technologies. This includes the successful participation in a new EU Horizon Europe funded project to accelerate the use of Artificial Intelligence and Machine Learning within the CCE pathway which will progress over the next year.

8.3 Case 2. DHI Exchange.

The DHI Exchange (previously DHI Demonstration & Simulation Environment) is an asset composed of two main capabilities.

- A physical place that can act as a place to bring together people, products and services to demonstrate the 'art of the possible'.
- A virtual sandbox in which multiple consumer and statutory digital products and platforms can interoperate and demonstrate their contribution to person-centred health and care service delivery.

DHI Exchange is an environment to help drive knowledge exchange around digital health and care innovation. The programme is aimed to address some of the systemic issues that stop digital health and care services scaling (as identified in DHI Phase 1). The DHI Exchange team focuses on making person-centred data-sharing infrastructure available to innovators, facilitating the integration of new digital capabilities into health and care services and with the goal of creating commercial opportunities in a global marketplace.

Main goals

The main goals of the project were to:

- Develop a model that was centred on citizens, not organisations. Maintaining this focus through discovery, design, and development as well as in the way in which infrastructure was

developed. This had to ensure that co-management with the citizen was a fundamental, unavoidable feature of the ecosystem.
- Developing and providing person-centred identity and data sharing infrastructure to allow citizens to connect digital health and care products and services to each other and existing health and care systems.
- Create immersive learning environments and demonstrations to help people understand the 'art of the possible' and use this to inform the design, development and commissioning of integrated, person-centred digital health and care services.

Approach

DHI developed a 'simulation' method that involved developing digital products that met user requirements, integrating these products with each other and with health and care systems and then using fake (simulated) data sets to demonstrate the new, integrated digital services in action. A physical **Demonstration Environment** was established to showcase these developments and provoke visitors to think differently about what service models were now possible. DHI also set up a virtual **Simulation Environment.** This provided technical sandboxes where developers could access the data-sharing infrastructure, allowing others to develop their own demonstrators.

Collaboration

Project partners have included NHS Greater Glasgow and Clyde, Edinburgh Napier University, and the businesses Sitekit, StormID, Atos, and mydex.

Initial design and simulation projects focused on hypertension and frailty. These simulations (alongside broader co-design and market research) were demonstrated in an immersive Demonstration Environment based at the University of Strathclyde. Over the first year, DHI ran weekly demonstration sessions, with over a thousand people attending from health and care services, industry, academia, and members of the public.

Outcomes

As a result of the Covid-19 pandemic DHI pivoted to support the NHS in developing the digital tools for the Scottish Test and Protect system. However, the methods and infrastructure used in early simulation exercises laid the groundwork to discover, design, integrate and deploy the necessary systems to quickly help Scotland in the pandemic.

While contributing positively to the Covid response (see section 3.3 above), the diversion of focus came at the cost of the intended broader innovation role, with interaction with the wider innovation community significantly limited. The pandemic also meant that the physical environment had to be closed to support social distancing requirements. Following an eighteen-month hiatus, DHI Exchange was relaunched and is positioned as a key national assets to support health and care service transformation and promote Scotland to international networks.

DHI note that some 120 virtual demonstrations have been delivered, with two simulations completed, six procurements completed, and two transferable digital solutions delivered as (of autumn 2022).

8.4 Case 3. Healthy Ageing Innovation Cluster.

Scotland's Healthy Ageing Innovation Cluster (HAIC) is facilitated by DHI on behalf of Scottish Government's Technology Enabled Care Team, The Digital Office for Local Government, Scottish Enterprise, Highlands & Islands Enterprise, Enterprise Europe Network and the European Connected Health Alliance.

Healthy Ageing is defined by the World Health Organisation as "the process of developing and maintaining functional ability that enables wellbeing in older age", and the aims of the cluster are to:

1. Create a collective of shared interests, expertise and skills.

2. Share information and support knowledge exchange.
3. Build collaborations that are greater than the sum of the individual parts.
4. Seek and solve demand-led challenges.
5. Identify funding/ host challenge opportunities.

The cluster comprises representatives from a range of civic organisations, academic institutions, citizens, commercial industry, healthcare professionals/ care providers and the third sector and cluster builds on the principles of Ageing 2.0, which is an international, interdisciplinary, and intergenerational community that strives to address the biggest challenges and opportunities in ageing.

To date, HAIC has been focusing on identifying, and giving a Scottish context to, opportunities within the Ageing 2.0 Grand Challenges as a frame of reference.

The cluster is free to join, and key elements of activity include:

- The network web site with meeting information, potential funding opportunities, and a series of online resources (e.g., meeting presentations and recordings, healthy ageing strategy and research documents, newsletters).
- Regular networking events including academic, business and civic partners, and with a focus on healthy ageing challenges.
- A Linked-in forum.
- Group newsletter.
- Links to related thematic workshops (e.g., a two day workshop on Brain Health and Technology delivered by Glasgow School of Art in partnership with Brain Health Scotland, and linking to project work on this topic with The Data Lab (i.e., Brain health Technology Challenge in October 2022).

Membership is currently noted at c1,000 members.

Delivery.

DHI has established a database for the cluster and regularly pushes opportunities to the members. It is noted that the cluster has been appointed by UKRI to act as a point of contact in Scotland for healthy ageing challenge funding.

A survey of members (2020) indicated that the top three cluster activities were:

- Identification of funding and collaboration opportunities.
- Sharing information and exchanging knowledge.
- Being part of a collaboration that is greater than the sum of its parts.

Further, a number of opportunities for further development were also identified:

- Distributing profiles/attendee lists prior to event to aid networking/Online capacity for making connections.
- Help to quantify the problems being addressed.
- More opportunities for pitches.
- Create a forum for developing new and innovative opportunities – led by cluster members.
- Honour those contributing.
- Bring in stakeholders who live with the issues the cluster is trying to address.

Outcomes.

A number of project outcomes were identified by the cluster (as of 2020). These included the following public sector (sponsors) achievements:

- 4 calls.
- 116 applications.

- 52 organisations.
- 23 projects approved.
- 18 launched.

For company members, the following achievements were noted:

- 261 applications to first 12 projects.
- 55 contracts awarded.
- 58% Scottish winners.

Wider benefits.

A number of wider benefits have also been identified by cluster members (2020), including:

- Provides a greater understanding of the front line challenges.
- Understanding the sector better.
- Useful to meet people and understand where they are coming from and why they might not understand or appreciate the same things you do.

More generally, it is noted that cluster activity around brain health, as discussed above, has fed into wider research DHI research submissions to, and steering group membership of, international collaborations in the field of brain health (and SFC funded Advanced Research Collaborative on brain health).

It is noted by DHI, that the cluster web site presence (and associated resources) has been influential in raising the international profile of the centre's work and stimulating new international partnerships (e.g., with the University of Dubai). Similarly, HAIC has expanded contacts via EU networks of clusters, and has established connections beyond the EU including North America, other Middle East locations, and Australia.

The work in establishing the HAIC, is also noted as being an important source of practice development that has informed to the development of other cluster initiatives around Digital Mental Health (currently at an earlier phase of development).

9 Conclusions.

In common with other ICs DHI was established to bring the expertise and capabilities of Scotland's universities, research institutes, colleges and businesses, to address industry demand led opportunities that support growth of the Scottish economy, and with a focus on in terms of digital solutions in health and care settings. This evaluation provides strong evidence that DHI is delivering against this vision and that is it bringing overall benefits to the Scottish economy, and society more generally though public sector service delivery improvements and through supporting opportunities for industry and academia to work collaboratively.

DHI is part way through their second phase and, as such, they are continuing to develop and evolve. The evidence presented in this evaluation, and highlighted below, demonstrates DHI is playing a substantial role in building the innovation ecosystem for digital health and care, delivering innovation outcomes and impacts for public sector organisations (particularly the NHS), and associated benefits for the private sector. The conclusions below are structured around the seven main evaluation objectives.

Assessing the extent to which ICs have delivered routes to economic benefit through increased levels of collaboration between industry and academia.

DHI is supporting a wide range of collaborative project activity between academia and industry, with high relevance to the strategic health and care context, and with strong alignment to the priorities of the NHS and SGHSCD.

Some 24 new collaborative projects have been established in Phase 2, an underestimate of overall contribution given incomplete MEF data for Phase 1, which have generated *at least* 42 commercial launches and other applications of innovation. Indeed, given DHI's demand-led approach with public sector partners (around co-design, testing, and implantation support), a quarter of these are associated with a new or improved delivery of a public service in Scotland. Qualitative evidence, including case studies, point to significant economic and wider benefits for Scotland from improved service delivery (such as that around COVID support, or the SCOTCAP development and roll-out), although the MEF does not capture this well, and further development of measurement approaches are required to report on these benefits more fully.

A wider lesson from the evaluation analysis is that intensity of engagement matters. Intensity of engagement in terms of duration of relationship with an IC, the range of supports, the number of repeat collaborative projects, the number of links supported to other ecosystem bodies (not only, but particularly, universities and colleges), all appear to have a positive effect on innovation outcomes and impacts. DHI's innovation process model provides a template to structure these relationships, especially around public service oriented challenges, and one that other ICs could learn from.

An implication for IC's is to be able to build and maintain client relationships (for example through membership and networking, having appropriate CRM systems, and the staffing to maintain and cultivate relationships with a degree of continuity. In this regard, DHI has undertaken significant steps in building a cluster membership, and is developing revised approaches to client record keeping.

Assessing the role each IC has played in supporting colleges and universities to maximise their value to Scotland.

While the client survey draws on relatively small sample size, it does demonstrate DHI's work with a range of academic institutions across Scotland, although student support has been focused to quite a high degree on the host university students (i.e., Strathclyde). Similarly maximising the contribution of colleges is perhaps where activity could be grown, building on the work with Glasgow College for example. CPD based skills development work is reaching large numbers, but the scale of higher degree support is lower in comparison with some other ICs, an area where, as some industry stakeholders suggest, that the scale of support could be increased. DHI also point to an influencing role in establishing digital health and care as core components in college courses.

Examining performance against targets and achievement of objectives.

Some nine of DHI's targets have been exceeded, with two on track (75% or over achieved), and some four are off track. Off track targets include challenge competitions hosted, academic grant awards, market research reports and work experience placements. Undoubtedly, the COVID pandemic has significantly impacted on some of these activities, in conjunction with the need to pivot to address COVID related challenges. In common with other ICs, skills development activities have been negatively impacted by the Covid-19 pandemic reducing placement possibilities and by Brexit reducing external funding and international students.

Given DHI's reorientation around broader digital challenges as they relate to health and social care service delivery, immediate evidence of impacts in terms of employment of GVA are limited and not reported in the MEF by agreement with the funders. As the DHI model matures these measures may become more relevant as more SME cluster members engage more directly in collaboration projects along with the growing private care sector.

Exploring how effectively each IC builds engagement with the innovation ecosystem.

There is strong evidence that DHI is engaging with and building innovation ecosystems. For example, DHI have supported *at least* 138 events across Phases 1 and 2, with extensive signposting from collaborative projects to other funding bodies, and with some 1,332 DHI innovation cluster members recorded as of July 2022. DHI clients indicate they have been significantly supported in establishing links with a wide range of ecosystem bodies, notably with the public sector, and universities.

It is also clear from the innovation ecosystem discussion above that, over Phase 1 and Phase 2 DHI are developing an innovation ecosystem across several dimensions, providing significant leadership, influence, partnership building and system strengthening and building system resources in term of visibility (including growing international visibility), knowledge and commercialisation or public sector service innovation.

Identifying wider impacts.

As well as building and strengthening the innovation ecosystems described above, DHI are contributing to wider societal goals, most notably in relation to human health and wellbeing. DHI demonstrates an array of wider impacts in line with its primary focus on societal challenges across healthcare via digital tools and services., and applicable to a number of health related challenges across themes including: cardiovascular; demand and capacity management, diabetes, cancer, chronic respiratory, digital skills, healthy ageing, citizen empowerment and mental health (as well as the COVID support already mentioned). As noted above, qualitative evidence, including case studies, point to significant economic and wider benefits for Scotland from improved service delivery, although the MEF does not capture this well, if at all, and further development of measurement approaches are required to report on these benefits more fully.

Assessing the degree to which IC benefits have reached all parts of Scotland.

Universities across Scotland are engaged with DHI. Survey clients tended to engage most often with GSA, but not exclusively so. Similarly, student support is concentrated in a relatively small group of institutions, primarily Strathclyde University. Therefore, there appears scope to maximise the value of a wider range of universities in Scotland in this regard.

While based on a small sample, the client survey also pointed to dominance of central belt clients (predominantly Glasgow and Edinburgh based establishments), with a lower representation in the HIE area (3%) and a further 3% in the Borders.

Identifying lessons learned from IC operations.

A change in host university arrangements caused some disruption to delivery in Phase one of the programme. However, the centre enjoyed positive relations with the current host university during the course of Phase two, despite constraints around pay and conditions common to most ICs. Hosting support, and the security provided, was commonly viewed by stakeholders to outweigh the risks of a more autonomous arrangement for IC governance.

DHI proved extremely effective at adapting its business plan in response to the Covid-19 pandemic. Providing strategic leadership, effective strategic influence and building on established strategic partnerships, the organisation made a significant contribution to the national Covid-19 response in the field of digital health and social care, with wide reaching benefits for economy and society through facilitating measures that supported coming out of lockdown. This work has also leveraged in additional investment as well as provided a platform for the further commercial development of projects involved.

DHI's innovation process model provides a template for ICs to structure longer term co-design relationships, especially around public service oriented challenges, and one that other ICs could learn from. This is particularly relevant given wider lessons from the evaluation analysis around the gains from intensity of engagement.

The MEF does not serve DHI well, in terms of how it captures wider results, and allows DHI to report against these. It is acknowledged there are challenges in developing suitable results chains and indicators that capture the wider heath and associated economic benefits flowing from these (for example quantitative measures around journey time savings, transport carbon savings, increase in lifetime earnings, reduction in delivery costs or qualitative measures on changes in beneficiary

perceptions or behaviours). However, a process that seeks to define a useful suite of this type of indictors would be helpful for all ICs.

Similarly, the high level objectives of the programme require modification to include the wider public sector improvement agenda of DHI and other ICs.