DECHI | DIGITALLY ENABLED CIRCULAR HEALTHCARE INNOVATION

DECHI
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YEAR 1 REPORT: JAN - DEC 2025

UKRI EPSRC FUNDED RESEARCH PROJECT
JAN 2025 – DEC 2027

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Executive Summary

DECHI's first year has established the core analytical, technical and engagement foundations required to accelerate circular innovation in UK healthcare. The programme has delivered a comprehensive Medtech taxonomy, early modelling and sensorisation tools, and sector-wide insights through extensive evidence reviews. Strong partnerships with NHS Trusts, industry, standards bodies and government have ensured alignment with national priorities and positioned DECHI as a connective hub in the emerging circular Medtech landscape. With workstreams now fully mobilised, the project enters Year 2 with a clear pathway towards deeper integration, scenario testing and system-level recommendations.

Project Overview

DECHI brings together leading interdisciplinary research capabilities and an extensive network of stakeholders to investigate how advances in digital technologies and digital approaches can accelerate the transition to a more sustainable and resilient healthcare system of the future using circular innovation. The focus is on medical technology (Medtech) and the application of the 'inner loops' of circularity (reuse, remanufacture, reprocessing) over recycling.

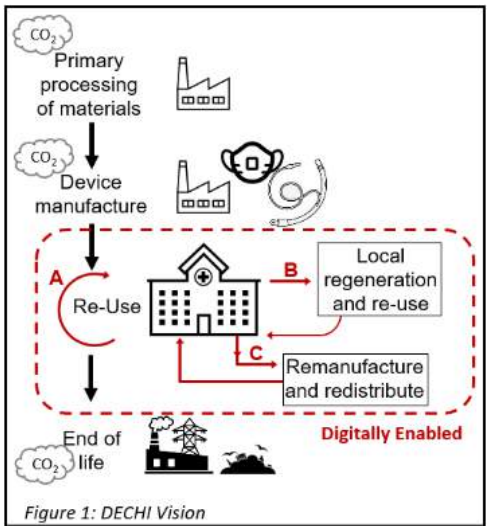


Fig 1: The DECHI vision

Research progress and key findings

The DECHI programme has made strong progress across all four workstreams in its first year, developing the analytical, technical and socio-technical foundations, and the stakeholder relationships, required to accelerate circular innovation in the UK Medtech sector. The summaries below highlight key achievements, evidence of progress against the plan, and priorities for Year 2 for each of the four workstreams.

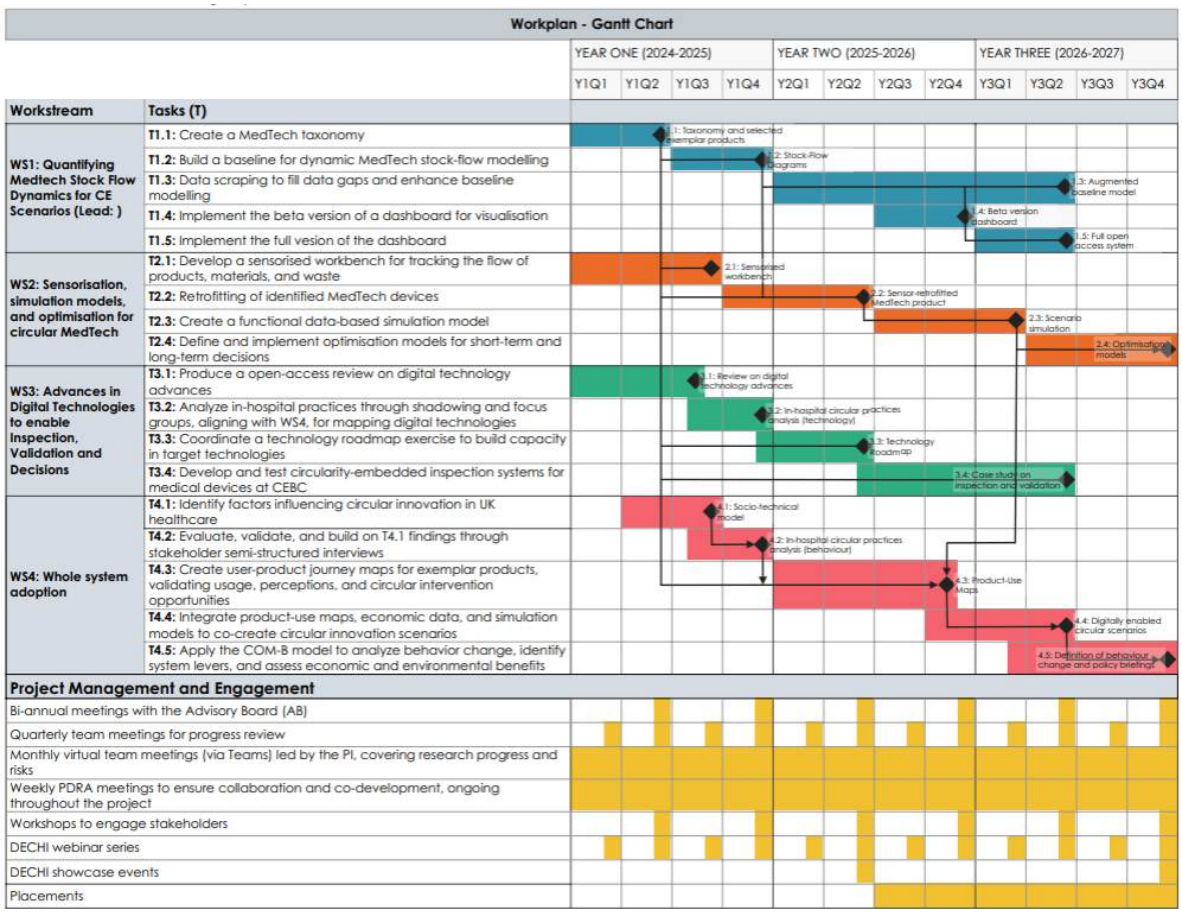


Fig 2: The workplan demonstrating progress and priorities for the four workstreams

Workstream 1 – Quantifying Medtech Stock-Flow Dynamics

WS1 is delivering the core analytical building blocks needed to understand the scale, distribution and circularity potential of Medtech across the UK. A comprehensive list of medical products has been created through systematic mapping across NHS organisations, DHSC, industry partners and academic collaborators. Analysis and classification of these diverse medical products have enabled the development of a structured taxonomy, capturing factors such as materials, risk class, clinical speciality, process complexity, procurement and disposal costs, and opportunities for reuse, repair or remanufacture.

The initial taxonomy and case-study modelling have been shared with key stakeholders, including at the EPSRC Manufacturing & Circular Economy Meeting (June 2025), Department of Management Research Showcase (May 2025), Sustainability Futures Seminar (October 2025), the Conference on Research Outcomes in Environmental Sustainability (October 2025), and members joined a House of Lords discussion on NHS Waste (July 2025). The DECHI Advisory Board members have also been instrumental in providing feedback and direction.

Initial modelling work on Harmonic Shears and Cool Sticks demonstrates both environmental and financial benefits of circular interventions and provides methodological templates for the expanded stock-flow modelling planned for Year 2. Formal data-sharing agreements (e.g., with UCLH) now enable deeper analysis at the hospital level.

Risks identified - particularly fragmented datasets, inconsistent coding systems and challenges accessing proprietary data - are being actively managed through cross-mapping frameworks, strengthened partnerships and phased prioritisation. Year 2 will focus on: taxonomy refinement using expanded datasets; publication of the systematic literature review; three further case studies; alignment with WS2–WS4 on data architecture; development of the dynamic stock-flow models for additional device categories; and creation of the beta dashboard for sector-wide use.

See Appendix A for the full report.

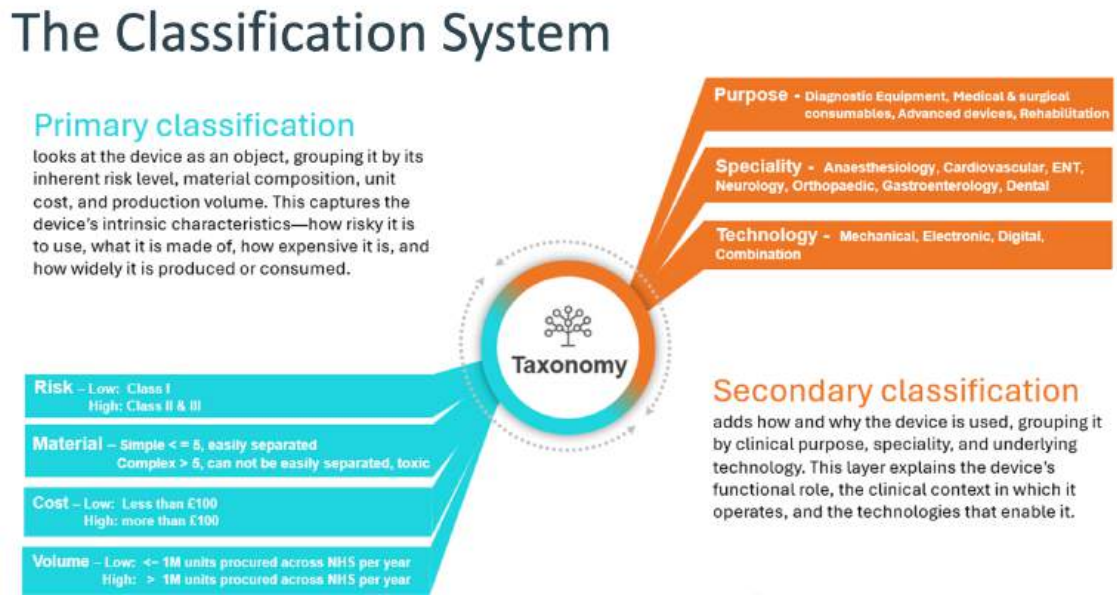


Fig 3: The Medtech taxonomy classification system

Workstream 2 – Sensorisation, Simulation and Optimisation

WS2 is developing the digital infrastructure required to determine optimal circular interventions for Medtech devices. A major Year 1 achievement has been the design and ongoing build of a sensorised workbench, incorporating an Intel RealSense D405 depth camera, infra-red sensors and a conveyor-based inspection environment. Computer vision approaches, such as YOLOv11, are being evaluated to support automated device classification and routing to appropriate Re-X pathways.

Alongside hardware development, the team has produced early Discrete Event Simulation (DES) and System Dynamics (SD) models in AnyLogic to evaluate how data

availability - including future Digital Product Passports - affects inspection timing, cost profiles and circularity outcomes. These models also support multi-year comparisons of linear versus circular system behaviour.

WS2 outputs have been shared at the INSIGNEO Showcase 2025, and two journal papers have been submitted for publication. Engagement with Philips, Surgical Holdings, AMRC, MTC and Data Connect has strengthened access to real-world challenges and datasets.

Key risks relate to limited standardisation and gaps in Re-X-related data. Mitigation includes working closely with OEMs, catapult centres and data hubs, and structuring modelling frameworks to accommodate staged data availability.

Year 2 priorities: complete the physical workbench; integrate hardware and computer-vision pipelines; run scenario testing across baseline, DPP-enabled and fully sensorised environments; and expand the SD toolkit into a visualisation resource for procurement and policy stakeholders.

See Appendix B for full report.

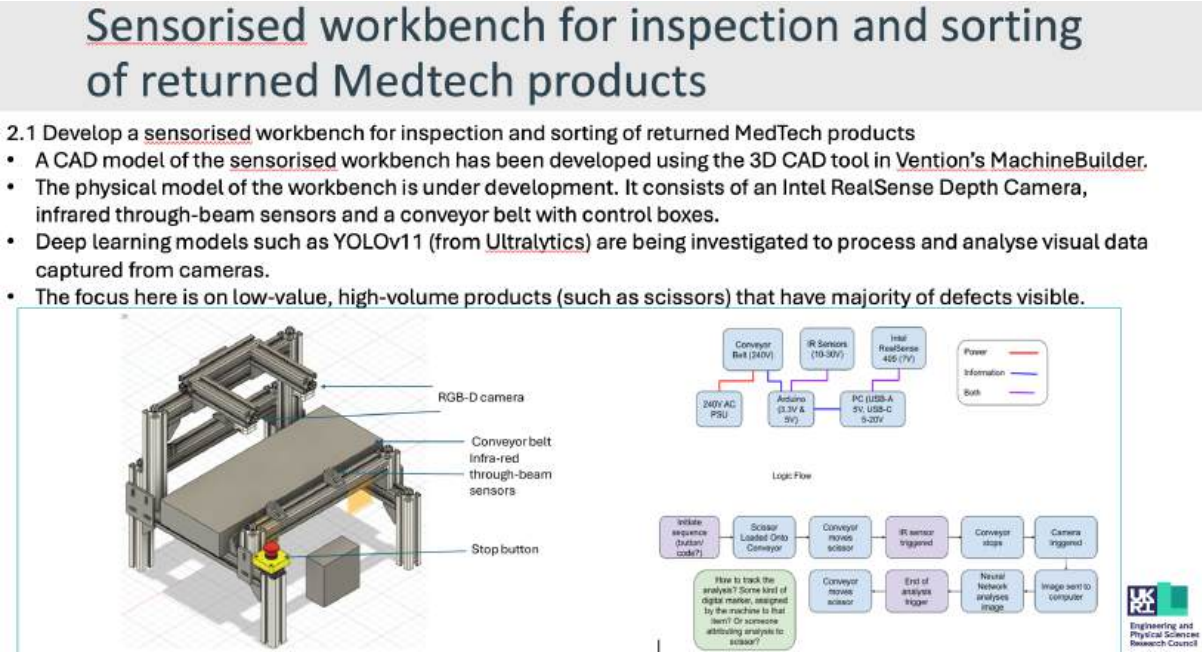


Fig 4: The sensorised workbench prototype for automated inspection and sorting

Workstream 3 – Digital Technologies for Inspection, Validation and Decision-Making

WS3 has completed an extensive evidence review, forming one of the most comprehensive compilations to date of reusable medical device performance, associated safety data, and digital technologies that can enable circularity. The review

consolidates 38 environmental case studies, over 30 safety assessments, and 82 examples of digital technologies used to support circularity in other sectors. This work has identified five key barriers to circular Medtech adoption: upfront cost, safety assurance, environmental impact of sterilisation, workflow complexity and OEM compliance.

Engagement with Addenbrooke's, UCLH, NHS Scotland, and the University of Leeds has prepared the ground for in-hospital shadowing and device-tracking exercises. Prototype concepts - including a Digital Product Passport demonstrator and a materials-recognition scanning tool - have already been initiated through undergraduate research.

WS3's work has also provided important leadership in aligning terminology across DECHI, addressing inconsistencies identified in prior Life Cycle Analysis (LCA) studies and regulatory language. This alignment is already supporting consistency across workstreams.

Risks identified relate to narrowing case studies, accessing manufacturing and materials data, and interpreting heterogeneous LCA methodologies. These are being mitigated through broad engagement, use of Design for Life networks and regular DECHI-wide terminology review.

Year 2 focus: finalise and submit the cross-workstream circular Medtech review for publication; begin in-hospital shadowing; host workshops to prioritise digital technologies needed to address identified barriers; and develop inspection and validation prototypes for testing at the Cambridge Centre for Better Care (CEBC).

See Appendix C for full report.

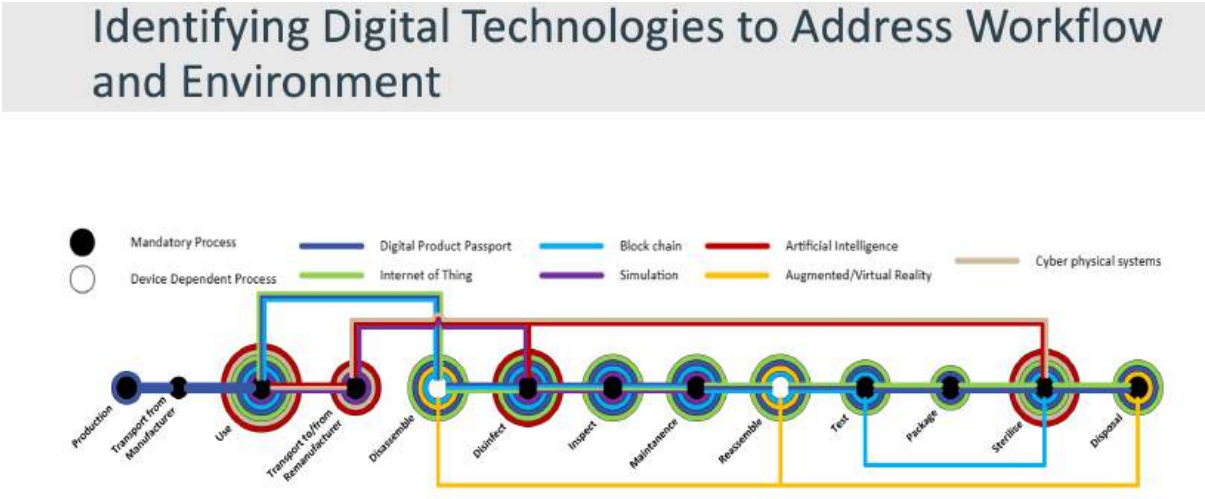


Fig 5: Flow diagram identifying digital technologies to address workflow and environment

Workstream 4 – Whole System Adoption

WS4 focuses on the behavioural, regulatory and organisational conditions required to enable system-wide uptake of circular Medtech. Although intentionally delayed to align with sequencing across the programme, preparatory work has ensured WS4 is well positioned for its January 2026 start.

Early engagement has built connections with DHSC, NHS England and the Design for Life team. WS4 will contribute to the forthcoming Behaviour Change Working Group being established to support a DHSC/NHSE public campaign around specific reusable products. Insights from the DHSC-commissioned Centre for Sustainable Healthcare report on reusable products have also been incorporated as baseline evidence ahead of PDRA mobilisation.

Engagement at the Circular Medtech Collaboration event (Glasgow, Oct 2025) has extended WS4's research network, particularly across social sciences and behaviour-change expertise.

The main risk relates to the compressed timeline due to the delayed PDRA start. This is mitigated by strong existing partnerships, clear scoping work already completed, and a well-defined roadmap drawing on outputs emerging from WS1–WS3.

Year 2 priorities: delivery of T4.1 and T4.2 through stakeholder interviews and observations; creation of user-product journey maps for exemplar devices; and integration of behavioural, economic and modelling insights to support scenario development later in the programme.

See Appendix D for full report.

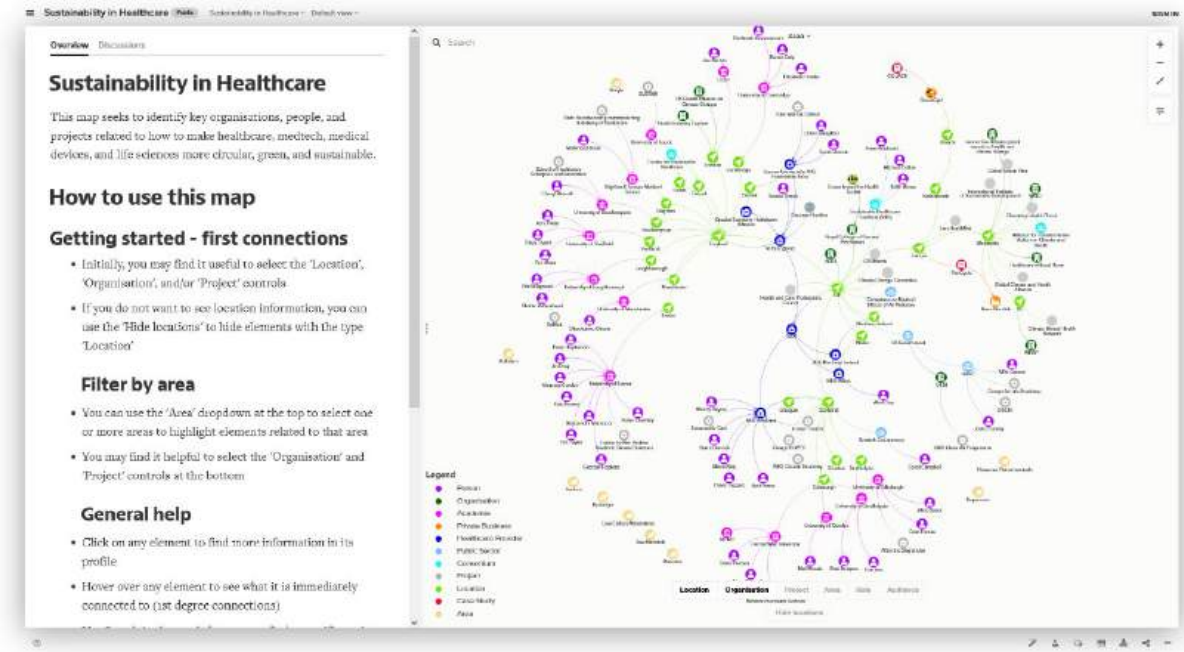


Fig 6: Research network mapping as an output from the Circular Medtech Collaboration event

Stakeholder Engagement

Stakeholder engagement has been a major strength of the DECHI programme in its first year, underpinning the project's impact potential and ensuring strong alignment with national priorities. Introductory meetings have been held with more than 30 partners across industry, policy, standards and the research community, including many who provided Letters of Support. This early outreach has created a broad coalition of collaborators and ensures that DECHI's research agenda remains closely connected to real-world needs.

The project was formally launched through a well-attended webinar in May 2025, with over 110 registrations and 68 participants. The event featured contributions from Surgical Holdings and the DHSC Design for Life team alongside the DECHI research team, demonstrating strong cross-sector interest and building visibility for the programme. Planned Autumn webinars were deferred to enable focus on a more strategically valuable opportunity: the Circular Medtech Collaboration event.

A major highlight of the autumn was DECHI's role as lead convener of the Circular Medtech Collaboration in Glasgow (7–8 October 2025), delivered in partnership with NHS Scotland and the Scottish Government. Bringing together over 50 attendees from 25 research projects, the event marked the first coordinated national forum dedicated to circular Medtech. Site visits to the NHS GG&C Laundry, QEUH service yard and Cowlairs Central Decontamination Unit provided practical insight into operational contexts, while a facilitated workshop identified shared priorities around data standardisation, upstream waste prevention, patient engagement, procurement practices and broader systemic enablers.

The event generated clear, measurable impact:

- Almost 90% of participants reported developing new collaborations or opportunities;
- Over 80% gained new perspectives that would shape their research;
- Almost 90% said they would have made less progress without the event.

As a direct outcome, DECHI has supported the DHSC Design for Life team in launching a Research Coordination Working Group. Terms of Reference are established and the first meeting was held on 22 Jan 2026, supported with attendance of 48 people from the research community. This positions the programme as a central convening force for UK circular healthcare research.

The project team has also prioritised its strategic relationship with DHSC's Design for Life initiative, contributing actively to the Advisory Board and aligning DECHI's outputs with the Government's Circular Medtech Roadmap. Ongoing work is now extending the

mapping of the UK circular Medtech research landscape to include industry and policy partners, strengthening DECHI's role as a national coordination point.

Overall, stakeholder engagement in Year 1 demonstrates strong commitment to impact, leadership in convening the national research community, and excellent value for public investment.

Fig: 7: The Circular Medtech Collaboration event in Glasgow

Publications List

Publication	Submission detail	Submission deadline	Status
Literate Review: Making Circular MedTech a Reality: Digital technology to support manufacturing, management and policy	Target Journal: British Medical Journal	Jan-26	Under prep
Digital product passport to inform the Re-X decisions in medical technologies	Journal: International Journal of Production Research	Jun-26	Under prep
Literature Review: Beyond Traditional Emissions Modelling in High Value Manufacturing: A Hybrid Approach for Net Zero Manufacturing	Journal: International Journal of Production Research	Jul-26	Submitted: Under Review
Automated inspection and sorting for CE in MedTech products	Journal or conference	Jul-26	Under prep

A conceptual hybrid modelling framework facilitates the evaluation of Scope 3 carbon emissions for high-value manufacturing	IEEE Access	Jul-26	Accepted
Literature Review: Circular Medtech Taxonomy	Journal TBC	Jul-26	Under prep
Literature Review: Determining Scope 3 emissions of high value manufacturing: Exploring methodologies, data, reporting standards and tools, theoretical framework, opportunities, and life cycle assessment techniques to achieve net zero manufacturing	Journal: Journal of Environmental Management	Jul-26	Under prep

Table 1: Publication submission status

Project outcomes & impact to date

Across its first year, DECHI has delivered a strong suite of outcomes that demonstrate both research progress and growing sector influence. Foundational analytical, technical and socio-technical capabilities have been established across all four workstreams, ranging from the development of a comprehensive Medtech taxonomy to early sensor-enabled inspection prototypes, simulation models, and one of the largest evidence reviews of reusable medical devices to date. These outputs are already enabling cross-workstream alignment and shaping the programme's long-term modelling, scenario development and adoption activities.

The project has also achieved significant impact through national engagement. DECHI has built an extensive network across NHS Trusts, industry partners, academic institutions and government bodies, with over 30 introductory meetings and active collaboration with Philips, Surgical Holdings, NHS Supply Chain, UCLH, NHS Scotland and the Design for Life team amongst others. The programme's convening role has been particularly notable: DECHI led the first national Circular Medtech Collaboration event in Glasgow, bringing together 50+ participants across 25 research projects and generating measurable outcomes in new partnerships, shared priorities and sector coordination. This has directly contributed to the launch of a new Research Coordination Working Group within Design for Life.

Early dissemination has further increased DECHI's visibility, with presentations at national conferences, contributions to parliamentary discussions on NHS waste, and journal submissions emerging from WS2 and WS3. Together, these achievements demonstrate that DECHI is already shaping the national conversation on circular healthcare, providing a robust evidence base, strengthening systemwide collaboration and positioning the programme as a key driver of innovation and impact as it moves into Year 2.

Project Management

Team & Operations

The project is led by the University of Exeter, supported by Georgie Hopkins (Project Manager) & Kate Frewer (Project Coordinator).

Monthly team meetings have been convened involving all team members, with two held in person (Sheffield in May 2025, and in Cambridge in January 2026), with the next in-person meeting scheduled in Sheffield in June 2026. Fortnightly meetings are led by the Research & Innovation Associates with a focus on workstream collaboration.

The project has helped to develop research capability through Early Careers Researchers, including PhD and Masters Students, being welcomed into the project team.

See Appendix E for details of the Research and Project Management team.

Data sharing

As key project partners are identified, Memorandum of Understanding are put in place outlining collaboration intentions, confidentiality and data sharing protocols.

Governance & Steering

Bringing together a cross-section of industry and policy partners, the Industrial Advisory Group was formed in April 2025, with defined Terms of Reference and chaired by Professor Paul Hatton from the University of Sheffield. Two meetings have been held online in Year 1 (June and December). The next meeting is scheduled for June 2026 to be held in person in Sheffield.

See Appendix F for details of the Industrial Advisory Group members.

Marketing & Communications

The DECHI project is presented through a dedicated page on the Exeter Centre for Circular Economy website, alongside a dedicated presence on LinkedIn, with 100 followers and over 300 page views. In Year 2, these channels will be used to share and extend the reach of project outputs and activities.

Finance

The project's financial position at the end of Year 1 remains positive, with expenditure reconciled at the lead institution and overall spending aligned with expectations for this stage of delivery. The profile of costs to date reflects the planned phasing of activity across the workstreams, particularly as staffing, engagement and technical development accelerated through 2025. While each partner institution is responsible

for managing its own direct spend, no issues have been raised to date, and the consolidated position indicates that the project is on track against the available budget.

Planning is already underway to profile anticipated expenditure for Years 2 and 3, including increased Directly Incurred costs associated with project showcase activity and broader engagement through DICE Network+ and Design for Life. Overall, the project is financially well positioned to support the expansion of delivery expected in the next phase.

CONFIDENTIAL						
Project ID	3331694	Start Date	01-Jan-2025		Report Date	06-Jan-2026
Principal Investigator	Fiona Charnley (FC378)	Project Duration	36 (months)		Status	Project Live
Project Title	Digitally Enabled Circular Healthcare Innovation (DECHI)	Lead Department	Management		Currency	Sterling
Actual Spend & Commitments Summary						
Directly Incurred / Exceptions						
		Budget	Actual Income / Expenditure	Current Actual Balance	Commitments	Available Budget
Staff (DI)		248,928.00	50,843.28	198,084.72	190,081.73	8,002.99
Temp Staff		-	1,958.70	- 1,958.70	-	- 1,958.70
Travel and Subsistence		13,130.00	3,388.50	9,741.50	-	9,741.50
Other Directly Incurred		26,051.00	475.00	25,576.00	-	25,576.00
Partner Costs						
		Budget	Actual Income / Expenditure	Current Actual Balance	Commitments	Available Budget
Other Expenditure						
		Budget	Actual Income / Expenditure	Current Actual Balance	Commitments	Available Budget
Staff (DA)		112,360.07	35,641.33	76,718.74	76,718.74	-
Estate Costs		72,234.60	20,240.27	51,994.33	51,994.33	-
Infrastructure Technician Costs		2,099.37	588.26	1,511.11	1,511.09	0.02
Indirect Costs		335,020.86	93,873.59	241,147.27	241,147.15	0.12
Income						
		Budget	Actual Income / Expenditure	Current Actual Balance	Commitments	Available Budget
Income - Overview		809,823.89	182,746.05	627,077.84	-	627,077.84
	EPSRC	640,825.00	-	640,825.00	-	640,825.00
	Institution Contribution	168,998.89	-	168,998.89	-	168,998.89
	Research Grant Income	-	182,746.05	- 182,746.05	-	- 182,746.05
	TOTAL	809,823.90	207,008.93	602,814.97	561,453.04	41,361.93

Fig: 8: Financial overview from Lead Institution showing reconciled spend to date

Risks & Mitigation

The first year of delivery has confirmed that DECHI is operating in a complex and evolving landscape that spans digital infrastructure, Medtech supply chains, NHS operational workflows and regulatory change. While each workstream has progressed well, common risks have emerged around data access and quality, dependency on partner engagement, interoperability across technical components and the sequencing required for successful whole-system adoption. These risks are consistent with those anticipated at proposal stage and have been actively managed through strengthened partnerships, iterative scoping and cross-workstream coordination. Mitigation actions taken in Year 1 place the programme in a strong position entering Year 2, particularly as workstream interdependencies deepen and whole-system behavioural analysis begins.

See Appendix G for full Risk Register

Year 2 project management focus

In Year 2, Project Management activity will focus on strengthening coordination across the programme and enhancing DECHI's engagement with key national partners. A

priority will be deepening collaboration with DICE Network+, using its convening power to support knowledge exchange, showcase emerging DECHI outputs and build connections across the wider circular healthcare community. We will also continue to develop our relationship with the Design for Life initiative to ensure alignment with national priorities around reusable products, behaviour-change campaigns and the development of supportive standards.

A further objective is to increase the visibility and accessibility of DECHI's research outputs. Alongside academic publications, we will work with the team to produce timely summaries and communications tailored to clinicians, manufacturers, policymakers and standards bodies, ensuring findings reach the audiences best placed to act on them.

Internally, we will continue to support effective cross-workstream collaboration, shared planning around exemplar devices and the integration of analytical, technical and socio-technical insights as the programme enters a more interconnected phase of delivery.

Conclusions

DECHI has moved from initiation to delivery of substantive outputs that now provide a strong platform for the programme's next phase. The workstreams are well aligned, early risks are being actively managed, and increasing cross-workstream integration is enabling richer technical and socio-technical insights. With expanded partnerships, maturing tools and clear priorities for Year 2, the project is well positioned to deliver deeper modelling, technology development, behavioural analysis and practical recommendations that can support a more circular, resilient healthcare system.

APPENDICES

Appendix A: Workstream 1: Detailed research progress and key findings

Building the Medtech evidence base
Workstream 1 has focused on establishing the technical and analytical foundation needed to understand Medtech stock-flow dynamics and circularity potential across device categories. This work now provides a robust platform for scenario modelling, cross-workstream alignment and policy-relevant insights.

T1.1 – Create a Medtech taxonomy
Status: Delivered on schedule.
A comprehensive long list of medical products has been produced, mapped across NHS, DHSC, industry and academic priorities.
A structured taxonomy has been developed capturing material composition, clinical specialty, risk class, process complexity, procurement cost, disposal cost and potential circular strategies (repair, reuse, remanufacture, recycling).
Taxonomy attributes are already under active validation through literature review and testing against early case studies, such as Harmonic Shears.
Initial findings were shared at several specific events, including:
EPSRC Manufacturing & Circular Economy Meeting (June 2025)
Department of Management Research Showcase (May 2025)
Sustainability Futures Seminar (October 2025)
Conference on Research Outcomes in Environmental Sustainability (October 2025)
Joined the House of Lords Discussion on NHS Waste (July 2025)

T1.2 – Baseline dynamic stock-flow model
Status: Substantial progress; case study modelling underway.
WS1 has adopted the previous CE-Hub protocol to model circularity potential for Harmonic Shears (high-risk, high-cost, multi-material device).
A new case study on Cool Sticks demonstrates significant material and financial savings when switching from chemical to physical cooling; digital enablement opportunities are under review.
This work contributes to establishing a baseline for future dynamic stock-flow modelling across broader categories.

T1.3 – Data scraping to enhance baseline model
Status: Scheduled to begin; no activity expected before Jan 2026.

T1.4–T1.5 – Dashboard development
Not yet in delivery phase, consistent with the forward-dated plan.

Key Outputs and Evidence of Value
Workstream 1 activities have produced a strong suite of early outputs that demonstrate progress towards the programme's intended outcomes:

Taxonomy accepted and shared across multiple national platforms (listed above), indicating strong sector uptake and interest.
Case-study evidence (Harmonic Shears, Cool Sticks) showing quantifiable environmental and financial benefits of circular practices.
Extensive collaboration network established with NHS Supply Chain (via Heidi Barnard), UCLH, Golden Jubilee Hospital, Philips, AMRC, and ESCHR (Netherlands), enabling access to real-world datasets and validation opportunities.
Formal data-sharing agreement with UCLH, enabling decentralised, hospital-level data access—critical for testing the taxonomy and modelling approach.
WS1 has aligned with procedural and system-level insights from the Net Zero HUT, enhancing whole-pathway understanding of circular potential.
These outputs directly support the DECHI Theory of Change by strengthening the evidence base needed for system transition and enabling alignment with the modelling, sensorisation and behaviour-change activities in WS2–4.

Risks Identified and Mitigation
1. Data fragmentation and inconsistent coding systems
Risk: Difficulty in unifying NHS, industry and academic datasets.
Mitigation: Developing a cross-mapping framework to standardise terminology and attributes.
2. Limited access to proprietary or sensitive procurement and usage data
Risk: Potential gaps in modelling completeness.
Mitigation: Formal agreements with UCLH and NHS Supply Chain; sustained engagement with industry partners (Philips, remanufacturers).
3. Resource and timeline pressures
Risk: Late WS1 start (April start vs January plan) required acceleration.
Mitigation: Parallel workplans, prioritisation of high-impact product groups.
4. Data accuracy and cleaning challenges
Risk: Heterogeneous data sources requiring intensive validation.
Mitigation: Ongoing validation with multiple researchers and stakeholder partners.

Upcoming Focus: Year 2 Priorities
Refinement and validation of the taxonomy using expanded datasets from NHS Supply Chain, UCLH and international partners.
Integration across WS2, WS3 and WS4, ensuring circularity metrics, data structures and reporting are interoperable.
Expansion of stock-flow modelling to additional device categories, including more complex capital equipment.
Development of the digital dashboard to enable visualisation of taxonomy, stock-flow and scenario outcomes (beta version targeted for late 2026).
Three additional device case studies by June 2026.
Publication of systematic literature review (by September 2026).
AMRC–Exeter Circular Medtech webinar (April 2026), reinforcing knowledge exchange.
These activities will shift WS1 from foundational analysis to operationalisation, providing decision-support tools and modelling capability for the rest of the programme.

Overall Summary
Workstream 1 remains on track in relation to its scheduled Year 1 activities. It has delivered the foundational taxonomy, built a substantial evidence base, and initiated modelling work aligned with the project's goals. Engagement has been exceptionally strong, generating access to real-world data and positioning WS1 as a central analytical engine for DECHI.

Appendix B: Workstream 2: Detailed research progress and key findings

Sensorisation, Simulation Models and Optimisation for Circular Medtech
Scope and emphasis: WS2 is building the practical digital capabilities (sensorised inspection, simulation and optimisation) required to decide the right circular intervention (repair, reuse, remanufacture—"Re-X") for the right device at the right time, and to quantify trade-offs between cost, carbon and operational performance.

T2.1 – Sensorised workbench
Status: Delivered on schedule, moving from design to physical setup.
A CAD model of the workbench has been developed in Vention's MachineBuilder.
Hardware stack specified: Intel RealSense D405 depth camera, infra-red through-beam sensors, and conveyor system with control boxes.
Computer vision approach under evaluation (e.g., YOLOv11 by Ultralytics) to classify returned products and determine the appropriate Re-X route.
Showcase output: Poster at INSIGNEO Showcase 2025: Digitally Enabled Circular Innovation in Medtech: Real-Time Sensing, Simulation and Optimisation.

T2.2 – Retrofitting identified Medtech devices
Status: In progress.
Target devices identified; non-intrusive sensor retrofits being scoped to capture usage, wear and condition signals for decision-timing.

T2.3 – Functional data-based simulation model
Status: Pre-start; foundational work underway.
AnyLogic models developed at Discrete Event Simulation (DES) and System Dynamics (SD) levels to evaluate Re-X impacts and Digital Product Passport (DPP) data availability.
Early DES shows how DPP and automation influence inspection timing, cost and routing decisions; SD framework set up to compare linear vs circular flows over multi-year lifecycles (see schematic in report).

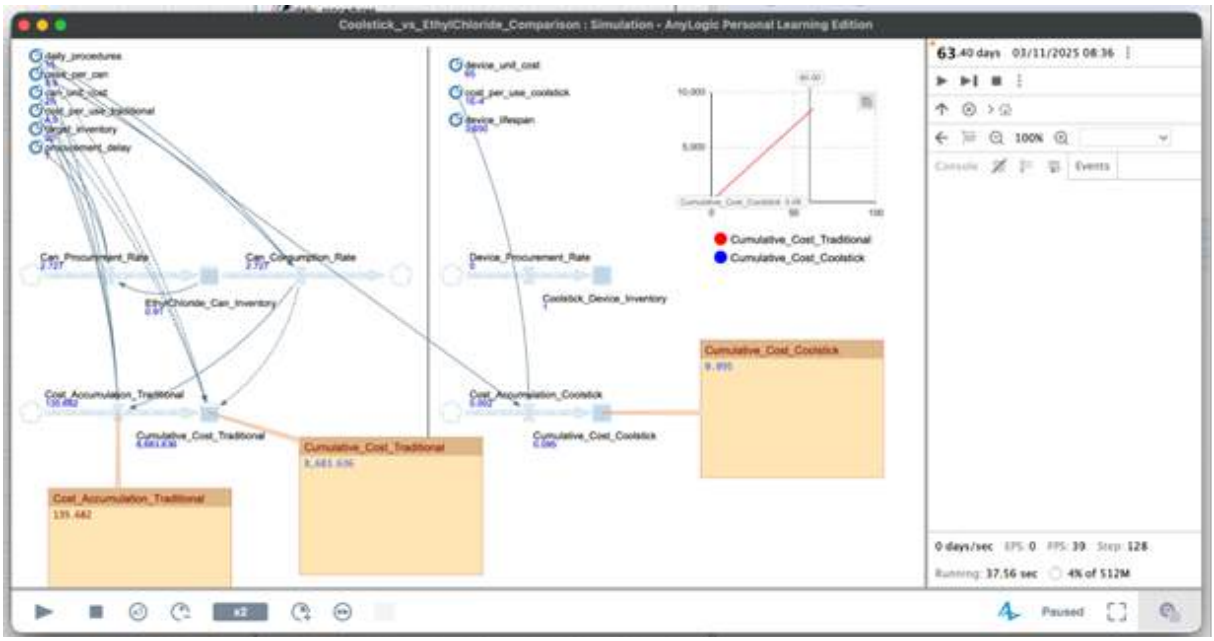
T2.4 – Optimisation models
Status: Future phase.
Planned to encode short- and long-term decision variables (e.g., cost, emissions, energy, recyclability, durability, regulatory compliance, patient outcomes, supply resilience).

Specific outputs and sector engagement

Poster: INSIGNEO 2025 (as above).
Publications:
Submitted: Beyond Traditional Emissions Modelling in High Value Manufacturing: A Hybrid Approach for Net Zero Supply Chains (IJPR).
Accepted: Conceptual Hybrid Modelling Framework Facilitating Scope 3 Carbon Emissions Evaluation for High Value Manufacturing (IEEE Access; aligned to Winter Simulation Conference, Dec 2025).
Collaboration: Engagement with Philips, Surgical Holdings, AMRC, MTC, and data centres (e.g., Data Connect) targeting data access and use-case relevance.
Cross-team working: Fortnightly PDRA meetings; plan to converge on a common use case across all workstreams.

Risks and mitigation
Data scarcity and lack of standardisation (DPP, Re-X decisions).
Mitigation: Proactive industry engagement (OEMs, SMEs), catapult centres and data hubs; modelling designed to accommodate data uncertainty and progressively incorporate DPP streams.
Interoperability and comparability of environmental/performance data.
Mitigation: Early design of hybrid modelling frameworks (DES + SD), and collaboration with partners to agree data structures for later dashboard integration.

Upcoming focus (Year 2)
Complete physical build and integration of the sensorised workbench; finalise and test computer vision pipelines; run design-of-experiments to assess feature detection across product variants.
Scenario testing in DES and SD: baseline (as-is), DPP-enabled (device metadata), and sensorised environment + device data combined.
Scale up SD toolkit into a flexible visualisation suite for strategic scenario planning (procurement and policy stakeholders).
Papers targeted:
i) DPP informing Re-X decisions (IJPR).
ii) Automated inspection and sorting for CE in Medtech (Journal of Cleaner Production).
iii) Physical demonstrator results for automated inspection/sorting.



Example of a System Dynamics simulation structure, as implemented in AnyLogic, for comparative scenario assessment of linear versus circular Medtech flows.

Appendix C: Workstream 3: Detailed research progress and key findings

Advances in Digital Technologies to Enable Inspection, Validation and Decisions
Scope and emphasis: WS3 is surveying and mapping the digital technology landscape, inside and outside healthcare, to identify the most effective inspection, validation and decision-support solutions for circular Medtech, and to pinpoint barriers where technology can unlock adoption.

Progress against planned activities
T3.1 – Open-access review on digital advances
Status: Literature review completed; manuscript in preparation for broad-reach journal (e.g., BMJ).
Compiled 38 case studies comparing environmental burdens of single-use vs reusable devices.
30+ safety studies comparing reused devices to new single-use equivalents.
82 case studies of digital technologies that enable circularity in non-healthcare sectors.
Mapped device flows from production to end-of-life; identified materials and technology barriers to circular implementation.

T3.2 – Analyse in-hospital practices via shadowing/focus groups
Status: Engagement initiated and case study scoping underway.
Established communication with Addenbrooke's (CUH), UCLH, Golden Jubilee (NHS Scotland), and University of Leeds' Sustainability Simulation Theatre.
Scoping Class I devices (simple, minimal materials) and Class IIa/IIb devices (multi-material, electronics) with consideration for data accessibility via Trust sustainability initiatives.

T3.3 – Technology roadmap
Status: Early mapping begun; formal roadmap exercise planned in coordination with WS1, WS2 and WS4.

T3.4 – Inspection/validation systems tested at CEBC
Status: Future phase; groundwork underway via case study selection and prototype planning.
Specific outputs and sector engagement
Comprehensive databases: environmental LCA comparisons (single-use vs reusable), safety profiles, and cross-sector digital technologies.
Barrier identification (five key areas):
High upfront cost;
Safety assurance;
Environmental burden of disinfection/sterilisation;
Workflow/device-flow complexity;
OEM compliance.
Prototyping support: Undergraduate projects at University of Cambridge exploring Digital Product Passport prototypes and material property recognition for device scanning/sorting.

Outreach and coordination:
Active engagement across NHS England/Scotland, Design for Life, and research groups (Leeds, Edinburgh); participation in Circular Medtech Collaboration (Glasgow, Oct 2025), Healthcare Sustainability Collaborative (Heriot-Watt), Sustainable Healthcare Coalition events, and All-Party Parliamentary sessions on waste.

Risks and mitigation
Case study narrowing and stakeholder suitability (data availability).
Mitigation: Maintain broad engagement while converging on jointly viable devices; leverage Trust sustainability teams to secure usable datasets.
Manufacturing/materials data access from OEMs.
Mitigation: Prioritise partners already supporting DECHI; extend outreach via Design for Life connections to widen the data network.
Terminology and methodological diversity in prior LCAs.
Mitigation: WS3 leads harmonisation of terminology across DECHI; regular cross-workstream meetings to refine definitions and ensure consistent interpretation.

Upcoming focus (Year 2)
Submit the cross-workstream review paper and commence shadowing/tracking of devices within participating NHS Trusts.
Run technology-needs workshops to prioritise digital inspection/validation solutions that address the five barriers.
Develop prototype technologies suitable for Trust integration and for wider reuse/repair/remanufacture pathways, anchored on agreed case studies.
Progress the technology roadmap and align with WS2 sensorisation and WS1 taxonomy for interoperability.

Appendix D: Workstream 4: Detailed research progress and key findings

Whole System Adoption

Scope and emphasis: WS4 addresses the socio-technical conditions required for system-level change—behaviour, regulation, standards, policy and business models—to enable the uptake of digitally supported circular interventions across UK healthcare.

Progress against planned activities

Start-up status: WS4's commencement has been intentionally delayed to align with the sequencing across WS1–3.

Recruitment: PDRA interviews complete; appointments made with confirmed start 5 Jan 2026.

Sector insight: Early engagement highlights relevant system-change resources, such as the DHSC-commissioned Centre for Sustainable Healthcare report on reusable products (adoption, barriers, enablers).

Coordination with DHSC/NHSE: DHSC (Josh Crosley) and NHSE (Tsanko Dimov) are developing a public campaign around a small set of products and initiating a Behaviour Change Working Group—WS4 will contribute actively once PDRA is in post.

T4.1 – Identify system factors

Status: Will be delivered in compressed timeline post-PDRA start, drawing on existing sector insight and networks.

T4.2 – Validate via stakeholder interviews

Status: To be carried forward into Year 2; preparatory networking undertaken.

T4.3 – User-product journey maps

Status: Scheduled to begin; ties directly to WS1 exemplar products and WS2 simulation outputs.

T4.4 – Integrate maps, economics and models into circular scenarios

Status: Future phase; will synthesise WS1–2 inputs.

T4.5 – COM-B behaviour change analysis and policy briefings

Status: Future phase; focus on recommendations for NHS, clinicians, policymakers and manufacturers.

Specific engagement and coordination

Circular Medtech Collaboration (Glasgow, Oct 2025): WS4 leadership engaged to expand social-science links and coordinate cross-project efforts.

Design for Life Advisory Group: Regular participation, feeding back sector insights and aligning WS4 plans with national delivery of the Circular Medtech Roadmap.

Partners: Philips, NHS England, DHSC & Design for Life, NHS Supply Chain, NHS Scotland/Scottish Government—network in place to accelerate WS4 once PDRA starts.

Risks and mitigation

Compressed timeline due to delayed start.
Mitigation: High-calibre PDRA recruitment; leverage existing insights, established partner network, and cross-workstream outputs to maintain overall delivery.

Upcoming focus (Year 2)
Kick-off WS4 with PDRA in post (Jan 2026).
Deliver T4.1–T4.2: identify and validate socio-technical factors via semi-structured interviews and observations across Trusts.
Begin T4.3: create user-product journey maps for exemplar devices, linking frequency/intensity of use, behaviours, care pathways and opportunities for digitally enabled interventions.
Align findings with WS2 simulation models and WS1 economic/data insights, preparing ground for T4.4 scenarios and T4.5 COM-B analysis.

Appendix E: DECHI Research & Project Management Team

First name	Last Name	Organisation	Role
Fiona	Charnley	Univ of Exeter	Lead Investigator, WS4 Lead
Peter	Hopkinson	Univ of Exeter	Investigator, WS1 Lead
Markus	Zils	Univ of Exeter	Investigator, WS1
Jin	Ding	Univ of Exeter	Research & Innov'n Assoc, WS1
Vinayak	Sharma	Univ of Exeter	Research & Innov'n Assoc, WS4 (shared)
Mayank	Jain	Univ of Exeter	Research & Innov'n Assoc, WS4 (shared)
Okechukwu	Okorie	Univ of Manchester	Investigator, WS2
Victoria	Omeire	Univ of Manchester	PhD student, WS2
Charles	Kolya	Univ of Manchester	PhD student, WS2
Ash	Tiwari	Univ of Sheffield	Investigator, WS2 Lead
Divya	Tiwari	Univ of Sheffield	Research & Innov'n Assoc, WS2 (shared)
Yuri	Mejia	Univ of Sheffield	Research & Innov'n Assoc, WS2 (shared)
Ronan	Daly	Univ of Cambridge	Investigator, WS3 Lead
Dushanth	Seevaratnam	Univ of Cambridge	Research & Innov'n Assoc, WS3
Hassan	Himaz	Univ of Cambridge	Intern (summer 2025), WS3
Elizabeth	Hawke	Univ of Cambridge	Intern (Sept-25 for 1 year), WS3
Georgie	Hopkins	Univ of Exeter	Project Manager
Kate	Frewer	Univ of Exeter	Project Coordinator

Appendix F: Industrial Advisory Group members

First Name	Last Name	Organisation	Position	Date of appt
Paul	Hatton	University of Sheffield	Chair	April-2025
Paula	Muir-McLeod	EPSRC, UKRI	Member	April-Aug 2025
Rehemat	Bhatia	EPSRC, UKRI	Member	August-2025
Daniel	Coole	Surgical Holdings	Member	April-2025
Josh	Crosley	Dept of Health & Social Care	Member	April-2025
Tom	Dawson	Revolution Zero	Member	April-2025
Tsanko	Dimov	NHS England	Member	April-2025
Tim	Felton	Manchester University NHS Foundation Trust	Member	April-2025
Richard	Hales	Cambridge University Hospitals Trust	Member	April-2025
Addie	MacGregor	ABHI	Member	April-2025
Amy	Newton	Medtronic	Member	April-2025
Shahin	Rahimifard	University of Loughborough	Member	April-2025
Wendy	Raynor	NHS Scotland	Member	April-2025
Chris	Taylor	Philips Health Systems	Member	April-2025
Clare	Topping	Northampton General Hospital NHS Trust	Member	April-2025
Lena	Cordie-Bancroft	British Standards Institute	Member	April-Sept 2025
Robert	Turpin	British Standards Institute	Member	October-2025

Appendix G: Risk register

Risk Category	Description of Risk	Likelihood	Impact	Risk Level	Mitigation Actions	Related Workstream(s)
Data fragmentation & inconsistent coding systems	NHS, OEM and academic datasets use heterogeneous identifiers, structures and coding conventions, limiting interoperability across WS1–WS3.	3	4	**12**	WS1 cross-mapping framework; ongoing terminology harmonisation led by WS3; expanded dataset access through UCLH data-sharing agreement; prioritisation of device types with more consistent data.	WS1, WS2, WS3, WS4 (ALL)
Limited access to proprietary or sensitive operational data	OEM data, Trust procurement information and in-hospital workflow datasets may not be fully accessible, constraining modelling, LCA comparison and simulation accuracy.	3	4	**12**	Formal MoUs and data-sharing agreements (e.g. UCLH); industry engagement through Philips, Surgical Holdings and AMRC; using multi-case sampling to avoid single-source dependency; aligning with Design for Life to widen access channels.	WS1, WS2, WS3, WS4 (ALL)
Data scarcity for Re-X and Digital Product Passport (DPP) scenarios	Early-phase modelling in WS2 requires structured DPP-type metadata and detailed device condition data that do not yet exist at scale.	3	2	**6**	Designing DES/SD models to accommodate staged data maturity; sensor-based data capture pipeline under development; early DPP prototyping in WS3; collaboration with NHS Scotland and CUH for device-tracking pilots.	WS2, WS3
Interoperability challenges across WS1–WS3 technical outputs	Taxonomy (WS1), sensorisation pipelines (WS2) and inspection/validation frameworks (WS3) risk divergence if not aligned early.	2	4	**8**	Fortnightly PDRA coordination; convergence on shared exemplar devices; WS3 terminology leadership; joint modelling workshops to define common data structures; Year 2 focus on dashboard architecture alignment.	WS1, WS2, WS3
Compressed WS4 timeline	WS4 mobilisation delayed to Jan 2026, requiring accelerated delivery of behavioural, regulatory and organisational analyses.	3	2	**6**	Strong preparatory work and partner engagement already completed; high-calibre PDRA recruited; clear roadmap; planned integration with WS1–WS3 outputs eases dependency on early WS4 fieldwork.	WS4
Case study narrowing & device suitability constraints	Real-world devices selected for modelling and technology development may face access, safety or data barriers.	3	2	**6**	Maintaining a broad pool of candidate devices; close collaboration with Trust sustainability teams; using low-risk Class I devices to establish early exemplars; iterative narrowing based on feasibility and data quality.	WS1, WS2, WS3, WS4 (ALL)
Hardware/sensor development dependencies (WS2)	Technical delays could slow integration of sensorised workbench and affect downstream modelling and validation.	2	2	**4**	Hardware stack already procured and in assembly; computer vision testing underway; modular design enables staged integration; DES/SD modelling continues in parallel.	WS2

Terminology inconsistency and methodological variance in LCA and environmental data	Lack of standardisation across existing LCA studies makes comparison, modelling and policy recommendations challenging.	3	2	**6**	WS3 leading terminology harmonisation; cross-workstream review cycles; alignment with BSI engagement and Design for Life standards activity.	WS1, WS3
Resource and timeline pressure due to early delays in WS1 start	April start compressed foundational taxonomy and modelling work.	1	2	**2**	Parallel workstreams; prioritisation of high-impact device categories; strong early outputs mean WS1 is now fully aligned to original trajectory.	WS1
Partner dependency for in-hospital shadowing and behavioural insights	WS3 and WS4 rely on NHS Trust participation, which may be affected by operational pressures.	3	3	**9**	Broad partner network reduces dependency; early engagement with CUH, UCLH, NHS Scotland and Leeds; embedding activity within existing Trust sustainability initiatives; flexible scheduling and multi-site approach.	WS3, WS4