May 2025

Evaluation of Made Smarter Innovation Industrial Strategy Challenge Fund

Final Report

SQW

Contents

Contact:
Sarah Brown
Tel: 07436 098652
email: sbrown@sqw.co.uk

Approved by:
Osman Anwar
Director
Date: 20/05/2025

Executive Summary

1. The manufacturing sector is important for the UK in terms of economic output, employment, and innovation. However, manufacturing as a share of gross domestic product has declined over the past two decades. There are a myriad of factors for this, including international competition, outsourcing, and loss of skills.

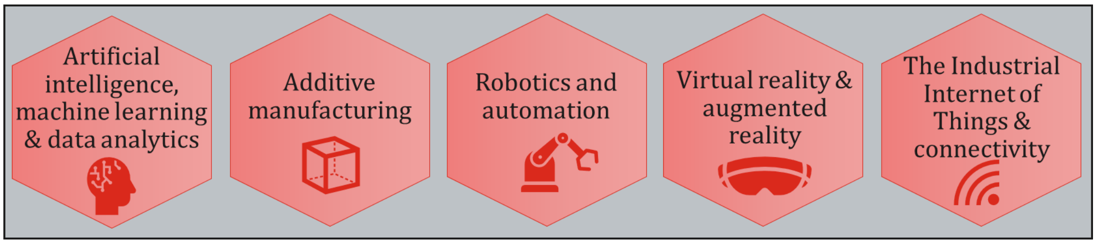
2. The Made Smarter Review (2017), commissioned by UK Government and led by Professor Juergen Maier (former Chief Executive of Siemens UK), explored how the integration of digital technology could support a real change in UK manufacturing through industry and government partnership. The Review identified that Industrial Digital Technologies (IDTs) could reverse the downward trends in manufacturing and potentially have a significant impact on the performance of the sector. Despite widespread recognition of the potential benefits of digitalisation, the UK has relatively low levels of adoption and exploitation of IDTs.

3. The Made Smarter Innovation (MSI) Industrial Strategy Challenge Fund (ISCF) MSI was launched in 2020 and received £129m over five years with £162m expected co-investment from industry. The Challenge objectives were to increase: investment and adoption of IDTs; cross-sector collaboration (including between industry and academia); the number of digital technology companies focused on manufacturing industries; and UK manufacturing and digital exports.

4. The Challenge delivery partners included: Innovate UK (lead), Engineering and Physical Sciences Research Council (EPSRC), Economic and Social Research Council (ESRC), Innovate UK Business Connect, the Digital Catapult, and the University of Ulster.

5. The programme focused on the five IDTs identified by the Made Smarter Review where there was clear potential to support enhanced innovation and application in the UK's manufacturing base:

Figure 1: IDTs in focus for the MSI Challenge



Source: SQW based on information from the Made Smarter Innovation Challenge

6. The programme delivered activities across seven workstreams:

Table 1: MSI Challenge workstreams

Collaborative Research & Development (CR&D)	Innovation Hubs	InterAct	Research Centres	Accelerators	Global
Applied research projects bringing together SMEs, large enterprises, and academic organisations to develop innovative IDT solutions	Two large projects offering a range of support to business, one focused on smart use of data, one on digitisation of supply chains	A social science research hub and multi-disciplinary network to identify solutions to overcome barriers to the development and adoption of digital technologies	Five Research Centres, each with a focus on key technological enablers for the manufacturing sector	Large 'sponsor' companies with specific issues brought together with SMEs to develop digital solutions	Supporting companies to develop international relationships
Made Smarter Innovation Network					
Using Innovate UK Business Connect's networks to facilitate cross-network engagement across the Challenge workstreams					

Source: SQW based on information from the Made Smarter Innovation Challenge

7. SQW, supported by the Institute for Manufacturing (IfM), IFF Research, and Frazer Nash, was commissioned by UKRI to evaluate the MSI programme. This final impact evaluation provides evidence on the additional outcomes and impacts of the programme as a result of MSI support. It is based on evidence from over 100 businesses, academics and stakeholders (alongside other research methods for data collection and analysis).

Key findings

8. The MSI Challenge delivered a programme of considerable scale, breadth, diversity and ambition during a period of economic and business disruption. It engaged with over 400 SMEs and facilitated multiple collaborations across businesses and across business and academia.

9. The programme yielded a strong set of technology and innovation outputs, including 356 technology solutions, 334 demonstrators, 570 use cases, and 430 publications. On outcomes, more than half of respondents to a survey of Challenge beneficiaries indicated that their technology had progressed by at least three Technology Readiness Levels (TRLs). There is evidence of the creation of intellectual property: 39 IP applications were made in relation to MSI-funded projects (noting that not all firms will apply to register their IP, preferring commercial secrecy, and many process innovations are not easily captured by a patent). The

programme also recorded the creation of 15 new digital technology companies and adoption of innovative digital solutions by over 600 businesses as a result of the programme.

10. These outcomes only represent a small proportion of the c.270k manufacturing firms in the UK. The scale of the barriers to adoption that were the rationale for the Challenge persist, including low levels of digital maturity in the manufacturing sector, particularly among SMEs. However, improved awareness of and understanding as to the potential uses and benefits of IDTs is an important element of increased IDT adoption and lays the foundations for continued IDT uptake beyond the programme period. The programme has made a difference in this respect. A number of Challenge initiatives focused on engaging firms with limited knowledge and awareness of IDTs. Most respondents to the beneficiary survey (81%) felt that participation in MSI had led to increased understanding of the application of IDTs.

11. There are early signs that the short term outcomes of the Challenge are starting to translate into longer-term outcomes: more than half (26/43) respondents to the beneficiary survey had achieved an increase in jobs, turnover or productivity as a result of MSI-funded projects. Significant achievement on these outcomes is not anticipated until 2026/27 and beyond.

12. The Challenge generated strong investment levels from industry. Companies invested almost £100m directly into Challenge activities against the £112m ISCF grant funding disbursed and an additional £102m into follow-on or related activities. Taken together, this £202m investment exceeded target by £40m. This is an encouraging result given the largest barrier to innovation, as identified by beneficiary survey respondents, was difficulty securing finance. This indicates that match-funding was key to unlocking investment in IDTs.

13. Another significant barrier to innovation was finding appropriate collaborators, particularly for digital technology developers. There was strong evidence that the Challenge's efforts to facilitate collaboration had contributed towards outcomes and impacts. Over 90% beneficiary survey respondents indicated that inputs from project partners had helped the realisation of project benefits and that collaboration was important to the outcomes generated.

14. The CR&D competitions were a key route to facilitating collaborations. Together they generated 894 collaborations, of which 174 were partnerships between business and academics, 185 were collaborations between manufacturers and technology companies, and 198 were partnerships specifically between SMEs and large firms. The opportunity to collaborate was partly enabled by funding, for example to participate in a CR&D project, but also by the networking opportunities and brokering service offered by various strands of the programme, in particular InterAct and the Network.

15. Importantly, the evaluation evidence indicated medium-to-high additionality for MSI. The Challenge helped to increase the speed, scale and quality of outcomes. Relatedly, over two thirds of beneficiary survey respondents thought that MSI was either the critical or an important contributory factor in achieving outcomes. The evidence from beneficiaries was supported by feedback from unsuccessful applicants, for whom not receiving MSI funding

slowed down/held back their growth. This finding reinforces the additionality of the MSI Challenge.

16. According to beneficiaries, other factors that supported programme achievements included availability of information about new technologies, other ongoing innovation activity, and pre-existing assets including relationships and networks. Factors that hindered progress included geopolitical and socio-economic issues (included the UK's exit from the EU, the Covid-19 pandemic and issues associated with the war in Ukraine).

17. Econometric analysis indicates that the MSI Challenge has had a positive statistically significant impact on the employment of 243 SME beneficiaries in scope for the evaluation. On average, following MSI support, the employment of beneficiaries was c. 14%-15% higher compared to unsuccessful applicants and similar but unsupported companies from the wider business population. Impacts on turnover were found to be statistically insignificant when the beneficiaries were compared to a group of similar unsupported companies selected from the wider business population. However, on average, following MSI support beneficiaries had c.23% higher turnover than is predicted by the path of unsuccessful applicants.

18. The results for employment and turnover reflect the often long pathways in the innovation and commercialisation process for companies: employment effects come first followed by measurable increases in turnover and productivity over time if projects are successful in the market. Notwithstanding this, the present value of benefits for the 243 SME beneficiaries in scope was estimated to be c. £168m in GVA (nearly all of this has been achieved so far). The benefits for SME beneficiaries were estimated over four years (the year of support and up to three following years) i.e. the analysis covered the period from 2019/20 to 2027/28 financial years, and included realised and expected benefits.

19. Overall, MSI represents value for money to date based on our assessment of the benefits and costs relating to a subset of MSI Challenge activities: CR&D, Digital Supply Chain Hub, and the Smart Manufacturing Data Hub. A fuller picture will emerge once the supported projects and technologies have had time to commercialise, penetrate the market and generate additional turnover and productivity benefits. The analysis is a partial view of value for money based on short-term impacts of the programme on employment of beneficiaries – and does not take account of displacement of jobs as it was not possible to accurately estimate this from the available evidence.

20. Reflecting on the findings, the MSI Challenge was a significant investment in encouraging innovation through emerging digital technologies. It operated through a period of considerable challenges that influenced its delivery and the ability of participating businesses to maximise the potential benefits. However, the Challenge was able to deliver a substantial, complex and wide-ranging set of interventions, engaging numerous SMEs and generating hundreds of technology solutions.

21. The evaluation showed how the Challenge delivered successfully against expectations to date, with indications of early outcomes. Realising the potential of the investment will depend on how effectively IDTs are adopted, not only by those participating in the Challenge, but in the sector more widely. There are signs that the wider environment for manufacturing will continue to be difficult, with higher taxes domestically and new tariff regimes internationally, which serves to reinforce the important roles of both MSI and the Made Smarter Adoption programme.

1. Introduction

1.1 The Made Smarter Innovation (MSI) Industrial Strategy Challenge Fund (ISCF)[1] was announced in July 2019 under the Industrial Strategy's Clean Growth Grand Challenge.[2] **The MSI programme sought to** ***"deliver a resilient, flexible, more productive and environmentally sustainable UK manufacturing sector."***[3] The programme included a range of activities designed to transform the UK's manufacturing and associated digital technology economy to be one of the most prosperous and productive in the world. The Challenge was intended to contribute to the wider impacts targeted by the Made Smarter Review (2017).[4]

1.2 The Challenge had five objectives, to increase:

- **UK manufacturing sector investment** in industrial digitalisation research and development (R&D) and **increase the adoption** of new Industrial Digital Technologies (IDTs)
- **cross-sector collaboration** between: academic disciplines, businesses and academics, and different businesses within the UK manufacturing sectors to avoid duplication and maximise IDT applications
- **the number of digital technology companies providing solutions** for manufacturing industries and providing UK sourced solutions at appropriate business scale
- **the number of collaborations** between SMEs and larger, more established companies up the value chain
- UK manufacturing and digital manufacturing solution exports, through demonstrable capabilities and products.

1.3 The programme was structured around seven main strands, each targeting a different stage of the R&D process and differing in scale, duration and timing, but all ultimately aiming to deliver a resilient, flexible, productive, and environmentally sustainable UK manufacturing sector. This breadth of scope is one of the important characteristics of the Challenge, bringing together more traditional grant funding with support for a much broader research base.

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[1] Made Smarter Innovation – UKRI

[2] The Industrial Strategy had four Grand Challenges, one of which was Clean Growth. There were eight Clean Growth Challenges, including MSI.

[3] Made Smarter Innovation – UKRI

[4] Maier, J. (2017) Made Smarter Review was an industry-led review which assessed how UK manufacturing industries can be transformed through the adoption of Industrial Digital Technologies. The review received contributions from more than 200 organisations and produced a set of recommendations that industry believed would achieve the UK's ambition of becoming a world leader in the Fourth Industrial Revolution by 2030.

1.4 The programme was allocated **£147m (£138m for workstreams, £9m for opex) over five years (2020-2025)** through the wider £2.6bn ISCF, with an expectation of **a minimum of £162m match funding from industry**, potentially providing a **total fund size of £309m**. The programme was eventually awarded **£129m for workstreams** due to wider Innovate UK spending pressures at the time of the Spending Review.

1.5 The key partners involved in delivering the MSI Challenge included: Innovate UK (lead), Engineering and Physical Sciences Research Council (EPSRC) and Economic and Social Research Council (ESRC). The Digital Catapult, the University of Ulster, and Innovate UK Business Connect (formerly Knowledge Transfer Network) were significant grant recipients, each with responsibility for delivery of a major strand of work.

Evaluation objectives and scope

1.6 SQW, together with the Institute for Manufacturing (IfM), IFF Research, and Frazer Nash, was commissioned by UKRI to evaluate the MSI programme. The evaluation commenced in July 2020 and comprised four phases (Table 1-1).

Table 1-1: MSI Challenge – evaluation phases

Phase 1	Report	Period
Phase 1	Evaluation framework	May 2021 – November 2021
Phase 2	Baseline	May 2022 – September 2022
Phase 3	Interim evaluation	November 2022 – May 2023
Phase 4a	Ad-interim evaluation	December 2023 – June 2024
Phase 4b	Final impact evaluation	August 2024 – March 2025

Source: SQW

Final impact evaluation report

1.7 This report is the final impact evaluation (Phase 4b) of the MSI Challenge. It provides evidence on the additional outcomes and impacts of the programme (achieved and expected) as a result of MSI support to manufacturing businesses, digital technology firms, academics and other relevant stakeholders. The focus of this report is on the research questions (RQs) set out below.

Table 1-2: Evaluation research questions

#	Research question
1	To what extent and how was the Challenge successful in increasing the UK manufacturing sector investment in industrial digitalisation R&D?
2	To what extent, and how, was the Challenge successful in increasing the adoption of new Industrial Digital Technologies?
3	To what extent, and how, was the Challenge successful in increasing the cross-sector collaboration between different academic disciplines, businesses and academics, and different businesses within the UK manufacturing sectors to avoid duplication and maximise Industrial Digital Technologies applications?
4	To what extent, and how was the Challenge successful in increasing the number of digital technology companies providing solutions for manufacturing industries and providing UK sourced solutions at appropriate business scale?
5	To what extent, and how was the Challenge successful in increasing the number of collaborations between SMEs and larger, more established companies up the value chain?
6	To what extent, and how, was the Challenge successful in increasing the UK manufacturing and digital manufacturing solution exports through demonstrable capabilities and products?

Source: UKRI and SQW

Report structure

1.8 This report is structured as follows:

- **Section 2:** Evaluation approach and methods
- **Section 3:** Context for the MSI Challenge
- **Section 4:** Logic model and theory of change
- **Section 5:** Inputs and activities
- **Section 6:** Outcomes and impacts
- **Section 7:** Additionality and contribution
- **Section 8:** Econometric analysis
- **Section 9:** Value for money
- **Section 10:** Conclusions.

1.9 This main report is supported by a separate Annex Report containing the following annexes:

- Annex A – SIC codes for Manufacturing and Digital Technologies sectors
- Annex B – Consultees
- Annex C – Further detail on methodology
- Annex D – Theory of Change assumptions
- Annex E – Survey analysis
- Annex F – Performance on output metrics
- Annex G – Performance on outcome metrics
- Annex H – Secondary data analysis
- Annex I – Econometric analysis
- Annex J – Technology trends
- Annex K – International comparison
- Annex L - Case studies.

2. Evaluation approach and methods

Overall approach

2.1 To understand the extent to which the MSI programme has delivered its objectives and the degree to which these are attributable to the programme, the evaluation used a **mixed methods approach,** incorporating two complementary approaches:

- **A theory-based approach** to test the extent to which outcomes and impacts have occurred as a result of the MSI programme (in line with the logic model and theory of change set out in Section 4) supplemented by **Contribution Analysis** (CA) to test the evidence on outcomes and impacts and assess the role of other factors in generating these benefits (see Annex Report for detail on CA).

- **A counterfactual approach** to assess the causality of the MSI programme in supporting participating businesses. We used econometric analysis to understand what would have happened to beneficiaries in the absence of MSI and estimate the net impact of MSI on business performance. This analysis focused on selected outcome measures: employment and turnover. The econometrics quantified the performance of beneficiaries against two comparison groups: unsuccessful applicants and a matched comparison group (further detail on this set out in section 8).[5]

Mixed methods

2.2 Our approach drew on both qualitative and quantitative data via two groups of research methods.

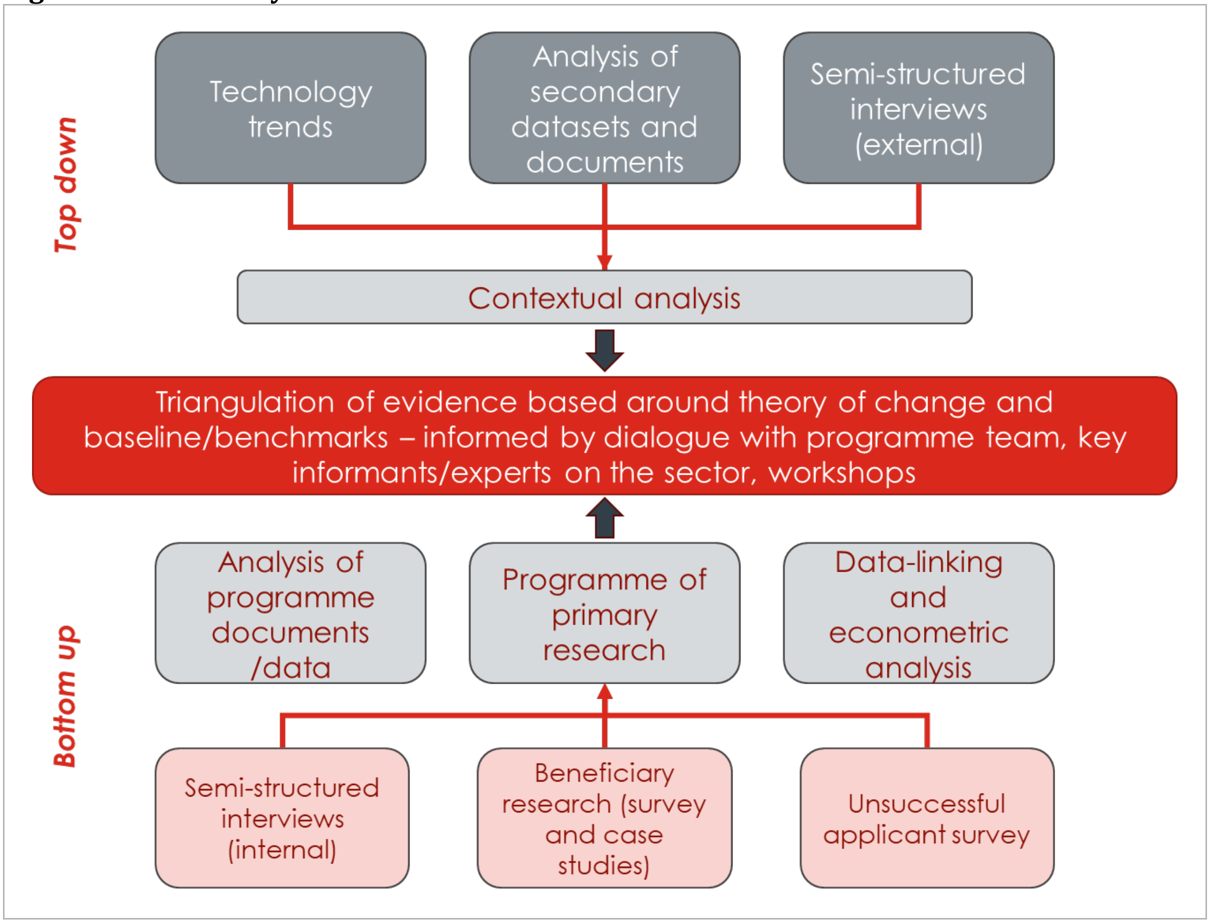
- The bottom-up methods provided evidence on delivery and performance for the individual strands and the Challenge as a whole. These included analysis of programme monitoring data, primary research with beneficiaries (via surveys and case studies) and stakeholders (via in-depth interviews), alongside engagement with unsuccessful applicants (via surveys to inform the counterfactual), and data-linking/econometric analysis of impacts.

- The top-down methods provided contextual evidence on changes in the manufacturing and digital tech sectors, and Industrial Digital Technologies (IDT) innovation landscape, to inform an understanding of pre-intervention conditions and how these developed during the Challenge. Methods included analysis of secondary datasets, review of IDT technology trends (focused on the programme's five IDTs), and international comparison of IDTs in UK manufacturing relative to wider international trends.

[5] This report implements the evaluation framework developed at the start of the study and also draws on the baseline, the process and the ad-interim reports. It is important to highlight that in this impact evaluation we have gone beyond the original scope/framework in relation to value for money assessment, specifically estimating a benefit-cost ratio for the Challenge.

2.3 The evidence from the two perspectives was triangulated and analysed against the MSI programme logic model and theory of change (see Section 4) and used to assess the plausible contribution of the programme (relative to other factors) at the Challenge and sector level to achievement of intended outcomes.

Figure 2-1: Summary of evaluation research methods



Source: SQW

Survey evidence

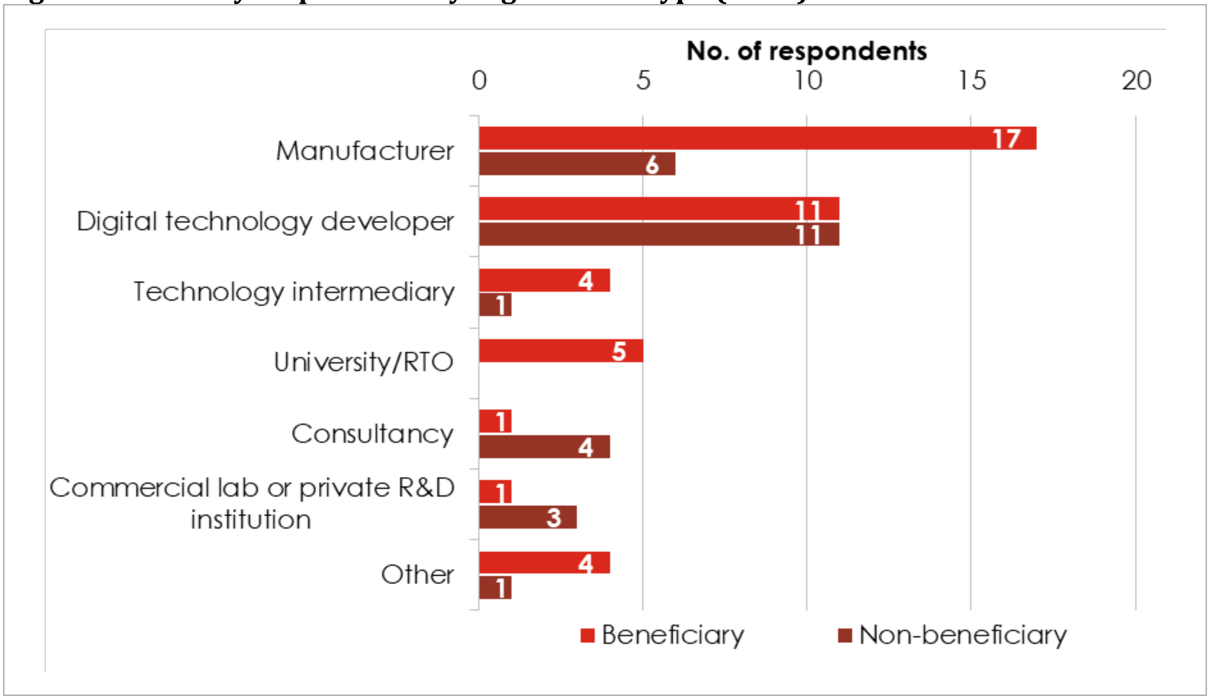
2.4 Two surveys were carried out across December 2024 and January 2025:

- **Beneficiary survey**: this included businesses and other organisations that were funded or participated in MSI projects. This included the CR&D programme, the Digital Supply Chain Innovation Hub (DSCIH) and the Smart Manufacturing Data Hub (SMDH). The known beneficiary population was 272 unique CR&D project partners and 64 organisations that received project funding from the Innovation Hubs. An initial contact list of 127 contacts with telephone numbers were provided by MSI, and another 131 contacts were identified through further research, giving a total population size of 258 contacts. All 258 were called multiple times. From this sample, 43 interviews were completed, representing a 17% response rate. This is a little lower than for comparable surveys but not unusually low.

- **Unsuccessful applicant survey**: this included businesses which applied for, but were not funded by, the MSI programme. This included applicants for the CR&D programme, the Digital Supply Chain Innovation Hub (DSCIH) and the Sustainability in Manufacturing competition. A list of 185 contacts with telephone numbers were provided by the MSI programme team. All 185 were called multiple times. From this sample, 26 interviews were completed, representing a 14% response rate. Unsuccessful applicant surveys tend to have lower response rates than beneficiary surveys so this is fairly typical.

2.5 Most respondents to both surveys were manufacturers or digital technology developers (Figure 2-2). However, there were also responses from research institutes, universities, and various other organisations. Respondents also varied in terms of their employment size, with representation across micro, small, medium-sized and large organisations.

Figure 2-2: Survey respondents by organisation type (n=69)



Source: SQW analysis of beneficiary and unsuccessful applicant survey data

Evaluation challenges

2.6 There were various challenges in the design and implementation of the evaluation. These included the interdependent nature of the programme's activities (and complementarities to activities outside of the programme), the varying and long timescales to outcomes and impacts, and the difficulties in attributing outcomes to the programme in light of multiple external influences. In reference to the latter of these, it is worth noting the following.

- A number of contextual changes occurred over the life of the programme that affected the manufacturing and digital technology sub-sectors. These include rising energy costs, disruption in supply chains,[6] access to relevant skills, and the legacy of the Covid-19 pandemic. These changes also influenced the MSI programme.

- The amount of public investment in the MSI programme, at £129m (excluding opex), was relatively small in comparison to the scale of the manufacturing and digital technologies sectors. This emphasises the importance of attracting private investment (programme target, £162m).
- A key challenge during delivery of the evaluation was the survey response rates. As described above, the beneficiary survey achieved 43 responses from 258 valid contacts[7] (i.e. 17% response rate). This is a lower response rate than we would have expected but is likely to have been influenced by the length of time since support was received for many beneficiaries. The unsuccessful applicant survey achieved a 14% response rate.

[6] Partly as a result of the UK's departure from the European Union.
[7] Valid contacts refers to contacts with correct contact details (e.g. phone numbers).

3. Context for the MSI Challenge

Summary

- The environment for MSI has been difficult, launching in the aftermath of the Covid-19 pandemic, adjusting to the implications of the UK's exit from the EU and the Russian invasion of Ukraine. At the same time, manufacturing output has continued to shift away from G7 countries to China, while UK manufacturing GVA as percentage of the UK total, has also slightly declined, over the past five years (from 9.4% to 9.0%).
- There have been changes in key economic, innovation, and environmental indicators since the MSI Challenge was established. These changes provide a mixed picture of the context for the Challenge in the manufacturing and digital technologies sectors.
- According to UKRI's Gateway to Research database, the total number of projects and public funding awarded across the MSI Challenge five IDT areas increased since the MSI baseline by 53% and 24%, respectively. This suggests a greater research interest in the five IDT areas.
- Similarly, there has been a substantial increase in the number of companies and the amount of private equity fundraising for IDT areas relevant to the MSI Challenge, mainly due to the rise in artificial intelligence firms and investment.
- Since 2021, technological progress across the five core IDTs has been uneven. AI has advanced rapidly and driven progress in robotics and automation. In contrast, additive manufacturing (3D printing), virtual and augmented reality (VR/AR), and the industrial internet of things (IIoT) have seen more minor developments.
- Key barriers remain such as cost and system integration for AI adoption, increasing robotic autonomy for wider adoption and navigating complex regulatory landscapes. The five core IDTs of MSI remain highly relevant to the UK manufacturing sector, offering opportunities for adoption.
- International approaches to supporting Industry 4.0 in selected countries highlight their greater emphases to the diffusion of technologies and best practice compared to the UK. In this context, the MSI Challenge plays an important role in supporting the manufacturing and digital technology sectors.

3.1 This section provides the context in which the MSI Challenge has been delivered. It provides the latest picture for the manufacturing and digital tech sectors, and how this has changed since the MSI Challenge baseline in 2019 (i.e. the pre-programme position).[8] This is based on secondary data analysis of key indicators: economic, innovation, and environmental.

3.2 The section also provides an overview of the technology developments in the core IDTs to understand how their positions have changed since the start of the MSI Challenge. It ends with a summary of international support for Industry 4.0[9] in competitor countries and how this compares with the UK. Further detail on the IDTs and approaches in competitor countries is available in the Annex Report. The analysis on technology developments and international competitors was prepared by the Policy Links Unit, part of IfM Engage based at the University of Cambridge.

3.3 **It is important to highlight that the data and information presented in this section are for contextual purposes. This is to understand the wider conditions influencing the MSI Challenge. The section is not intended to, and should not be interpreted as, commenting on the performance of MSI** (i.e. MSI did not *cause* the wider contextual conditions).

Overview

3.4 The Challenge has operated in a very difficult environment. It launched in the aftermath of the Covid-19 pandemic as businesses faced the implications of the UK's exit from the EU and, slightly later, the Russian invasion of Ukraine. High energy costs, supply chain shocks, and a tight labour market have made investment and growth particularly difficult. More generally, the manufacturing sector has faced the continuing shift of manufacturing output away from G7 countries to China and in the past five years UK manufacturing GVA has slipped from 9.4% to 9.0% of the UK total.[10]

3.5 The recent University of Cambridge UK Innovation Report (2025)[11] states that *"more concerning is the UK's loss of competitiveness in high value-added industries. Over the past decade, the most significant declines in global export shares have occurred in historically strong sectors, including pharmaceuticals and other transport equipment, which covers aerospace, shipbuilding, and railway equipment"*.

3.6 Within the UK, over the past decade, employment has been shifting towards less well-paid sectors with lower productivity. However, manufacturing continues to be vital for several reasons. First, it is one of the sectors with the fastest productivity growth, meaning that any growth in manufacturing contributes disproportionately to overall productivity and growth. Second, it has a wider impact on the UK economy through it supply chains. The UK Innovation Report estimates

[8] MSI activities started in 2020.
[9] Digital transformation in the manufacturing sector.
[10] ONS (2025) GDP output approach – low-level aggregate.
[11] Cambridge Industrial Innovation Policy (2025). UK Innovation Report 2025. IfM Engage. Institute for Manufacturing, University of Cambridge. https://www.ciip.group.cam.ac.uk/wp-content/uploads/2025/03/UK-Innovation-Report-2025.pdf

that manufacturing generates significant indirect economic and employment effects, accounting for around 15% of UK value added and employment.

3.7 The Challenge has also been delivered over a period when innovation across all sectors has fallen. Over the past two UK Innovation surveys (2018-20 and 2020-22) the percentage of "innovation active" firms fell from 45% to 36% of all firms, and from 69% to 62% among engineering manufacturing firms.[12] Despite this, the number of firms engaged in the IDTs identified by the Challenge has grown rapidly, as has investment.

3.8 The new UK Government has prioritised economic growth and two of eight of its growth-driving sectors relate directly to the MSI Challenge; advanced manufacturing, and digital and technologies.[13] It stresses the important role of manufacturing as a driver of innovation, saying: *"our industrial base plays an important role in our future economic resilience, as a significant dependency for many of our services sectors and as a driver of innovation"*. This focus on growth and productivity further strengthens the importance of the role of the Challenge.

Secondary data analysis of key indicators

3.9 The tables below bring together key indicators for the manufacturing and technology sectors, public investment in the key IDTs and manufacturing, and the fundraising by the businesses working with these technologies. The tables show the latest available data and, where appropriate, the change from the baseline values in 2019.[14] A full list of the data sources and definitions is available in the Annex Report.

3.10 Overall, our analysis of key indicators reveals a mixed picture of the context in which the MSI Challenge has been delivered i.e. in terms of the change in economic, innovation, and environmental conditions since the MSI Challenge baseline. We highlight the following changes since the start of the Challenge.

- **Economic** – the GVA of the manufacturing sector has decreased slightly (in real terms) since the baseline, whilst the GVA of the rest of the economy has grown. As a result, manufacturing now contributes a slightly smaller proportion of the overall UK economy. Employment in the manufacturing sector has remained about the same over that period. This has led to a small increase in labour productivity (measured as GVA per employee). Manufacturing exports decreased slightly as did the proportion of all exports made up by manufacturing. The economic indicators for the digital technologies sector show a real terms rise in GVA and employment, and a decrease in exports.

[12] DBT (2024) United Kingdom innovation survey 2023: report, available here.
[13] Invest 2035: The UK's modern industrial strategy. https://www.gov.uk/government/consultations/invest-2035-the-uks-modern-industrial-strategy/invest-2035-the-uks-modern-industrial-strategy
[14] Additional data in the 2024 'UK Manufacturing: The Facts 2024' report by MAKEUK, available here.

- **Innovation** – the proportions of "innovation active"[15] engineering and non-engineering manufacturing companies were slightly lower in the most recent available data. According to the UK Innovation Survey (2024),[16] the proportion of engineering manufacturing companies described as "innovation active" decreased between 2018-2020 (baseline) and 2020-2022 (latest), by around seven percentage points. The same was true for non-engineering manufacturing companies, which fell by a similar amount. Business expenditure on R&D by the manufacturing sector and the digital technologies sector as a proportion of GVA were around 5% and 6%, respectively in 2022. The latest available figures cannot be directly compared with the baseline in 2019 due to changes in the ONS definition.[17]

- **Environment** – Greenhouse Gas (GHG) emissions and energy use continue to decline in the manufacturing sector (an 8% and an 11% reduction on the baseline, respectively) – energy use has decreased more than the UK as a whole (the UK decreased by 9% in the same period), but GHG emissions have decreased less (the UK decreased by 11% in the same period). This decline is also reflected in the digital technologies sector.

Table 3-1: Manufacturing sector – key indicators (inflation adjusted)

Indicator	Baseline (2019)	Latest data	Year of latest data	Change since baseline
Economic				
GVA (£bn) †	208.5	206.9	2024	Similar
GVA as % of whole economy	9.4%	9.0%	2024	⬇
Employment (m)*	2.4	2.4[18]	2023	Similar
Employment as a % of whole economy*	7.8%	7.4%	2023	⬇
Productivity (GVA per employment) (£, in 2022 prices)**	84,597	86,718	2022	⬆
Value of manufacturing exports (£bn, in 2024 prices)	212	197	2024	⬇
Value of manufacturing exports, as a % of all exports	53%	50%	2022	⬇
Innovation				

[15] A business is considered 'Innovation Active', if it has introduced new or improved products, introduced new business processes, or engaged in an innovation project within the survey period.
[16] Department for Business and Trade (2024) UK innovation survey 2023, available here.
[17] The weighting of businesses in the survey has been changed so it is more representative of the UK as a whole.
[18] In 2024, there were 2.6m jobs in the Manufacturing sector, similar to 2019 (2.7m).

Indicator	Baseline (2019)	Latest data	Year of latest data	Change since baseline
Business expenditure on R&D (£m, in 2023 prices)	11,134	10,700	2023	Cannot compare***
Business expenditure on R&D, as a proportion of GVA**	4.9%	5.2%	2023	Cannot compare
% of engineering manufacturing "innovation active"[19]	69%	62%	2022	↓
% of non-engineering manufacturing "innovation active"	58%	52%	2022	↓
Environmental				
GHG emissions (000s tonnes of CO_2 equivalent)	80,113	73,497	2023	↓
GHG emissions intensity (000s tonnes of CO_2 equivalent/£m)	0.41	0.37	2023	↓
Energy use all sources (million tonnes of oil equivalent)	38.0	34.7	2022	↓

Source: ONS, DBT (See Annex Report)

Data on employment is only available for Great Britain, not United Kingdom;SQW calculation; ***The ONS definition of business expenditure on R&D has changed since the baseline, so these numbers should not be compared; †Chained volume measure; Note: A double arrow indicates an increase or decrease of 10 percentage points or greater*

Table 3-2: Digital Technologies sector – key indicators (inflation adjusted)

Indicator	Baseline (2019)	Latest data	Year of latest data	Change since baseline
Economic				
GVA (£m)	120,947	139,473	2024	↑↑
GVA as % of whole economy	5.5%	6.1%	2024	↑
Employment (m)*	1.3	1.4	2023	Similar
Employment as a % of whole economy*	4.2%	4.4%	2023	Similar
Productivity (GVA per employment) (£, in 2022 prices)**	£101,920	£114,853	2022	↑

[19] These figures are for the period 2018-2020 (baseline) and 2020-2022 (latest).

Indicator	Baseline (2019)	Latest data	Year of latest data	Change since baseline
Value of digital technology exports (£bn, in 2022 prices)	13.5	10.9	2022	↓↓
Innovation				
Business expenditure on R&D (£m, in 2023 prices)	4,246	9,096	2023	Cannot compare***
Business expenditure on R&D, as a proportion of GVA**	2.6%	6.6%	2023	Cannot compare
Environmental				
GHG emissions (000s tonnes of CO_2 equivalent)	858	746	2022	↓↓
Energy use all sources (000s tonnes of oil equivalent)	1.1	1.0	2022	Similar

Source: ONS, DBT (See Annex Report)
** Data on employment is only available for Great Britain, not United Kingdom;** SQW calculation; ***The ONS definition of business expenditure on R&D has changed since the baseline, so these numbers should not be compared; †Chained volume measure; Note: A double arrow indicates an increase or decrease of 10% or greater*

Gateway to Research – public investment in IDT research

3.11 An important measure of research activity is the number and value of projects being funded through the main government funding programmes. UKRI's Gateway to Research (GtR) provides data on publicly funded research and can be analysed using specific search terms to provide a picture of the activity from the year before the MSI Challenge was operational.

3.12 Across all funded research projects, we identified **2,439 unique projects** funded between 2019 and 2023, that related to one of more of the IDT related technologies and manufacturing. These projects were awarded a total of c. **£1.5bn**. This represents an average of over £620k per unique project. We highlight the following changes for the period 2019-2023:

- the total number of projects increased from 383 in 2019 to 587 in 2023 (increase of 53%)
- the total public funding across the IDT research areas increased by c. £80m (24%)

- public funding for research in additive manufacturing and robotics increased, whilst for AI and IoT it decreased.

Table 3-3: Number of research projects with some public funding – Gateway to Research

Research Area	Baseline (2019)	Latest data (2023)	Change since baseline
Artificial Intelligence (including Machine Learning and Data Analytics)	157	270	↑↑
Additive Manufacturing	96	138	↑↑
Robotics	138	233	↑↑
Internet of Things	26	33	Similar
Virtual / Augmented Reality	107	127	↑↑
Total	383	587	↑↑

Source: Gateway to Research, UKRI
Note: One project may be assigned to more than one research area
Note: A double arrow indicates an increase or decrease of 10% or greater

Table 3-4: Public investment into technology research – Gateway to Research

Research Area	Baseline (2019)	Latest data (2023)	Change since baseline
Artificial Intelligence (including Machine Learning and Data Analytics)	£171m	£143m	↓↓
Additive Manufacturing	£54m	£74m	↑↑
Robotics	£128m	£237m	↑↑
Internet of Things	£46m	£16m	↓↓
Virtual / Augmented Reality	£87m	£90m	Similar
Total	**£338m**	**£418m**	↑↑

Source: Gateway to Research, UKRI
Note: One project may be assigned to more than one research area
Note: A double arrow indicates an increase or decrease of 10% or greater
Note: Current prices

Beauhurst – private investment in IDTs

3.13 To provide further context for the evaluation, data from Beauhurst has been collated on wider trends across the UK digital technologies investment landscape.[20] Data was downloaded for tracked companies tagged with one of more of the following Beauhurst 'buzzwords': 3D printing, artificial intelligence, augmented reality, Internet of Things, robotics and virtual reality.

3.14 The tables below present data on the number of companies and the amount of (cumulative) equity fundraising for IDT areas relevant to the MSI Challenge, with further detail provided in the Annex Report.[21] We highlight the following from our analysis of the Beauhurst data:

- there are 10,293 companies with a HQ in the UK that are tagged with at least one off these buzzwords, an almost 400% increase on the number at the baseline stage (2,132)
- this increase has mostly been driven by a large spike in the number of companies tagged with 'Artificial intelligence' which has increased from 1,318 to 7,661 (an increase of c. 480%), with other technology areas also showing increases
- aside from artificial intelligence, Internet of Things, virtual reality, augmented reality and robotics had broadly similar levels of investment
- the largest fundraising growth was in virtual reality (310%), 3D printing (300%), and augmented reality (210%).

[20] Beauhurst is a database of business performance and public/private investment data for potential high-growth companies in the UK (https://www.beauhurst.com/)
[21] The fundraising figures are cumulative and so 2025 figures cannot be compared to the baseline 2022.

Table 3-5: Number of companies by Beauhurst buzzword, and as a proportion of all businesses tagged with at least one buzzword

Buzzword	Baseline (2022)	Latest data (2025)	Change since baseline (% increase)
3D printing	90 (4%)	221 (2%)	↑↑
Artificial Intelligence	1,318 (62%)	7,661 (74%)	↑↑
Augmented reality	208 (10%)	403 (4%)	↑↑
Internet of Things	389 (18%)	985 (10%)	↑↑
Robotics	158 (7%)	914 (9%)	↑↑
Virtual reality	282 (13%)	762 (7%)	↑↑
Total	**2,132**	**10,293**	↑↑

Source: Beauhurst
Note: A double arrow indicates an increase or decrease of 10% or greater
A business may be tagged with more than one buzzword

Table 3-6: Total cumulative fundraising by companies, by Beauhurst buzzword

Buzzword	Baseline (2022)	Latest data (as at March 2025)
3D printing	£146m	£587m
Artificial Intelligence	£8bn	£22bn
Augmented reality	£656m	£2.0bn
Internet of Things	£2.7bn	£3.8bn
Robotics	£1.2bn	£1.9bn
Virtual reality	£531m	£2.2bn

Source: Beauhurst
Note: Cannot compare latest and baseline data as figures are cumulative

Technology developments

3.15 This sub-section summarises some of the developments relating to the IDTs since the MSI baseline, and the implications for the Challenge. Further detail is presented in the Annex Report.

3.16 Since 2021, technological progress across the five core IDTs has been uneven. AI has advanced rapidly, particularly with large language model (LLM)-based AI software following OpenAI's launch of ChatGPT in November 2022. Given their language capabilities, many experts anticipate that LLMs would contribute to manufacturing by serving as a conversational gateway between humans and machines.

3.17 AI breakthroughs have also driven progress in robotics and automation, particularly in embodied AI. Unlike digital AI, embodied AI operates through agent-based systems, such as robots, that can physically interact with objects and people in the real world. More advanced than pre-programmed robotics, embodied AI systems feature self-learning capabilities, allowing them to adapt to their surroundings using diverse sensors. In contrast, additive manufacturing (3D printing), virtual and augmented reality (VR/AR), and the industrial internet of things (IIoT) have seen relatively minor developments.

3.18 The five core IDTs remain highly relevant to the UK manufacturing sector, offering significant opportunities for further adoption. According to a survey conducted by Make UK in 2024, *"Generative AI is fairly evenly distributed between businesses considering it (34%) and those using it (28%), suggesting that many organisations are actively exploring or adopting the technology. However, only 7% of companies have successfully introduced this technology, indicating that full-scale adoption is still in development"*.[22] For AI and machine learning in general, 8% of the manufacturers successfully adopted this technology in their businesses With just 119 robots per 10,000 manufacturing employees, the UK has the lowest robotics adoption rate among G7 countries.[23] Adoption of VR/AR is similarly slow, with 22% of manufacturers exploring or implementing the technology, but only 5% achieving full integration.

3.19 Additive manufacturing (AM) shows stronger progress, with 51% of manufacturers introducing it and 10% successfully adopting it by 2024.[24] The UK government has launched several initiatives to accelerate AM adoption. For example, the Manufacturing Technology Centre (MTC) in Coventry serves as the National Centre for Additive Manufacturing (NCAM). Its mission is to advance AM technology and promote its adoption across various industries.[25] Between January 2013 and July 2023, UKRI spent over £550 million on 811 AM-related projects.[26]

3.20 Several common barriers hinder the adoption of the five core IDTs. Cost and system integration are the most significant challenges for AI adoption, with 44% of manufacturers in the Make UK survey citing these as key obstacles. Similarly, increasing robotic autonomy is crucial for wider adoption in production lines, reducing the need for human intervention and reprogramming.[27]

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22 Make UK, "Future Factories Powered by AI", available at https://www.makeuk.org/insights/reports/future-factories-powered-ai

23 The National Robotarium, "Why 2025's Industrial Strategy must close Britain's manufacturing robotics gap", available at https://thenationalrobotarium.com/why-2025s-industrial-strategy-must-close-britains-manufacturing-robotics-gap/#:~:text=With%20just%20119%20robots%20per,economies%20like%20Mexico%20and%20Turkey

24 Make UK, "Future Factories Powered by AI", available at https://www.makeuk.org/insights/reports/future-factories-powered-ai

25 MTC website, available at https://www.the-mtc.org/additive-manufacturing

26 Additive Manufacturing UK, "AMUK Annual Action Plan 2024," available at https://additivemanufacturinguk.org.uk/wp-content/uploads/2024/01/AMUK-2024-Annual-Action-Plan.pdf

27 Made Smarter, "How To Introduce Industrial Robots - Industry 4.0 - Made Smarter", available at https://www.madesmarter.uk/resources/blog-how-to-introduce-industrial-robots-successfully-into-your-sme/

3.21 Navigating complex regulatory landscapes is another challenge, particularly for additive manufacturing, robotics, and automation. However, with the emergence of 6G, both the UK government and industry see an opportunity. In 2023, the UK Government launched its 6G Strategy, committing an initial £100m to research.[28]

3.22 Broader challenges in UK manufacturing also affect technology adoption. Limited supply chain awareness hampers AM uptake, while concerns over job displacement may slow robotics adoption. In IIoT, many IoT components are manufactured abroad, despite the UK's strong position in R&D and design.

3.23 The above highlights the variation in technological progression across the five IDTs and the continued barriers to the adoption within the IDTs and more widely in the manufacturing sector. The context for the MSI Challenge continues to the difficult and multifaceted, in turn influencing the nature and level of benefits generated by the Challenge.

International approaches

3.24 This sub-section summarises international approaches to supporting Industry 4.0 in selected countries, including Germany, United States, Singapore, Korea, and Taiwan. Detail on each country's Industry 4.0 programme is provided in the Annex Report.

3.25 The international approaches reviewed identified access to incubators, test facilities, and other prototyping environments where businesses can develop and implement the solutions to their problems and opportunities. For example, Germany provides testbeds[29] in R&D institutions to help companies try out new ideas – with the support of industry experts – and put their own technologies, product or customer interfaces to the test before making an investment. Similarly, Korea's Ministry for SMEs and Startups aims to support SMEs' innovation capacity, across all industries, with a focus on SME uptake of digital manufacturing.[30]

3.26 Most Industry 4.0 initiatives represent top-down government strategies, but they vary in their implementation and delivery institutions. While many provide new funding and may form new committees to guide their strategic focus, most rely on existing organisations to facilitate the implementation at a local level.

3.27 In the US, Industry 4.0 support is deployed nationally through their national network of institutions providing industrial advisory services (see below). Other countries are able to use their regional institutions (e.g. Japan's prefectural technology centres[31] and Korea's regional

[28] DSIT, "UK Wireless Infrastructure Strategy", available at https://www.gov.uk/government/publications/uk-wireless-infrastructure-strategy/uk-wireless-infrastructure-strategy
[29] Germany. Federal Ministry for Economic Affairs and Climate Action (2022) Testumgebungen https://www.plattform-i40.de/IP/Navigation/DE/Angebote-Ergebnisse/Kompass/Testen-Testumgebungen/testen-testumgebungen.html
[30] Ministry of SMEs and Startups (2020) Smart Manufacturing Innovation Promotion Team
[31] For example, WINTEC https://www.wakayama-kg.jp/english/

technology institutes) and manufacturing extension services (e.g. the US Manufacturing Extension Partnership[32]) to deliver digital diffusion initiatives. Smaller countries such as Korea and Singapore are less likely to have a regional focus but may support clusters such as Singapore's Jurong Innovation District.

3.28 Industry 4.0 initiatives in the other countries reviewed also involved funding for education and workforce training. In Korea and Singapore, for example, demonstration facilities are used to deliver practical training courses on Industry 4.0 to industry personnel. Singapore's Economic Development Board created the Skills Future Series for Advanced Manufacturing,[33] which provides modular courses aimed at helping the manufacturing workforce acquire new skills and accelerate Industry 4.0's development. In the US, the MxD Institute[34] (one of the Manufacturing USA Institutes), has developed 'Digital Manufacturing Jobs', an initiative which identifies roles in manufacturing that will be created or transformed by the introduction of digital technology.

3.29 The Industry 4.0 messaging from countries such as Germany, Korea, and Taiwan appear to be at least partially externally-oriented, and part of a signalling to international corporations about readiness to do business (the utilisation of the German 'Industrie 4.0' as opposed to, say, the 4th Industrial Revolution, functions in part as an advertisement for German manufacturing as world-leading).

3.30 A key difference between the UK approach and that of other countries reviewed, is that the latter have a stronger emphasis on the diffusion of technologies and best practice, and are able to use their regional institutions and manufacturing extension services to deliver digital diffusion initiatives.[35] In this international context, the MSI Challenge is an important intervention given its focus on increasing UK manufacturing investment in industrial digitalisation R&D, cross-sector collaboration and the adoption of IDTs.

[32] NIST: https://www.nist.gov/mep
[33] For example, SkillsFuture (2024) Skills Future Series https://www.skillsfuture.gov.sg/initiatives/mid-career/series
[34] https://www.mxdusa.org/
[35] https://www.ciip.group.cam.ac.uk/reports-and-articles/comparing-the-uks-response-to-industry-4-0-an-international-perspective/

4. Logic model and theory of change

Strategic context and rationale

4.1 Whilst manufacturing remains a vital sector within the UK's economy, it has experienced a relative decline compared to growth in services. This is the case for most developed countries but the trend has been particularly marked in the UK, with manufacturing decreasing from c.20% of Gross Domestic Product (GDP) in 1990 to just 10% of GDP in 2015. A myriad of factors has contributed to this declining share of GDP including outsourcing, a loss of skills, and international competition.[36]

4.2 Within this context the UK Government set out a call to industry in the Industrial Strategy Green Paper (January 2017)[37] to establish a vision for growth and increased productivity across the manufacturing sector. Industry responded in the Made Smarter Review (published in 2017) in which it put forward a set of recommendations that it believes can achieve the UK's ambition of becoming a world leader in the Fourth Industrial Revolution by 2030.

4.3 The Made Smarter Review (2017)[38] identified that IDTs could reverse the downward trends in manufacturing, potentially having significant impact on the performance of the sector. It was estimated that over the coming decade the impact of IDTs on the UK economy could be as high as £455 billion for manufacturing, increasing manufacturing sector growth between 1.5 and 3% per annum. In turn, this could generate an estimated net gain of 175,000 jobs, a 4.5% reduction in CO_2 emissions (in the context of a global shift towards clean growth), and more than 25% improvement in industrial productivity.

"Industrial digitalisation is the application of digital tools and technologies to the value chains of businesses who make things (e.g. in the automotive and construction industries) or are otherwise operationally asset intensive (e.g. power grids and wind farms). These technologies enable the physical and digital worlds to be merged, and can bring significant enhancements to performance and productivity. We call these technologies industrial digitalisation technologies (IDTs)."[39]

Made Smarter Review (2017)

4.4 Despite widespread recognition of the potential benefits of digitalisation, the UK has relatively low levels of adoption and exploitation of IDTs. In part, this can be explained by a lack of translation of new technologies from research to industry, including a lack of innovative and digital start-ups. A survey of manufacturing businesses conducted by The Manufacturer in late 2019 found that: many IDTs had been adopted by under a third of survey respondents, adoption varied by sub-sector and business size, and adoption was related to the maturity of the

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36 Ibid 4.
37 HM Government (2017) Building our Industrial Strategy Green Paper
38 Ibid 4.
39 Ibid 4.

underpinning technology and its commercial application.[40] These trends have become more pronounced and significant in recent years as other countries have strived to create industrial digital leaders and promote the early adoption of IDTs (for example, Germany, USA, and China). This context poses a significant threat to the future competitiveness of UK manufacturing.

4.5 There are other market failures and barriers affecting the manufacturing sector in relation to the adoption of IDTs, as identified in the MSI Business Case.[41]

- **Information failures** caused by a lack of information about potential new technologies, and insufficient communication between digital suppliers and manufacturers regarding market opportunities.
- **Coordination failures** that make addressing large scale and multidisciplinary challenges complex and challenging. Differences in the adoption and application of digital technology across industrial sectors requires cross-sector information sharing to maximise benefits to all UK manufacturing.
- **Network failures** due to specialisation and fragmentation within supply chains. In addition, fear of competition or confidentiality can lead to large firms underinvesting in supplier development.
- **Market power**, meaning that adoption is prevented by technology lock-ins due to the use of proprietary solutions and lack of (open) standards. In addition, manufacturing sectors struggle to secure funding for technological innovation, whilst innovation assets to support start-ups/scale-ups are under-leveraged.

4.6 MSI was designed to address these market failures and meet the recommendations on innovation in the Made Smarter Review. Its primary recommendation was to *"create a much more visible and effective digital innovation ecosystem to accelerate the innovation and diffusion of technologies in manufacturing."*[42] This recommendation was broken down as follows:

- invest in a new National Adoption Programme
- scale the support provided by UK innovation centres through a new national innovation programme
- implement large-scale Digital Transformational Demonstrator programmes within the Digital Innovation Hubs, co-funded by industry
- drive forward the UK's global IDT research and development leadership.

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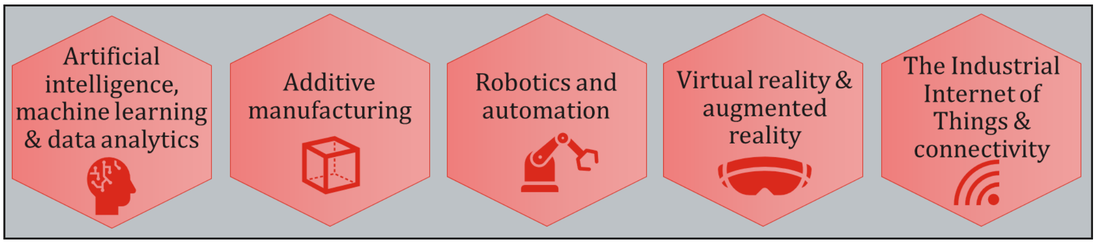
[40] The Manufacturer (2020) Annual Manufacturing Report 2020
[41] Industrial Strategy Challenge Fund: Manufacturing Made Smarter Challenge Business Case (August 2019)
[42] Ibid 4.

4.7 The Review specifically identified five IDTs where there was clear potential to support enhanced innovation and application in the UK's manufacturing base and where the UK was currently behind competitors: these IDTs are the principal focus of MSI (Figure 4-1).

Figure 4-1: IDTs in focus for the Challenge



Source: SQW based on information from the Made Smarter Innovation Challenge

Challenge Objectives

4.8 The MSI ISCF commenced in early 2020 with the following **five objectives**:[43]

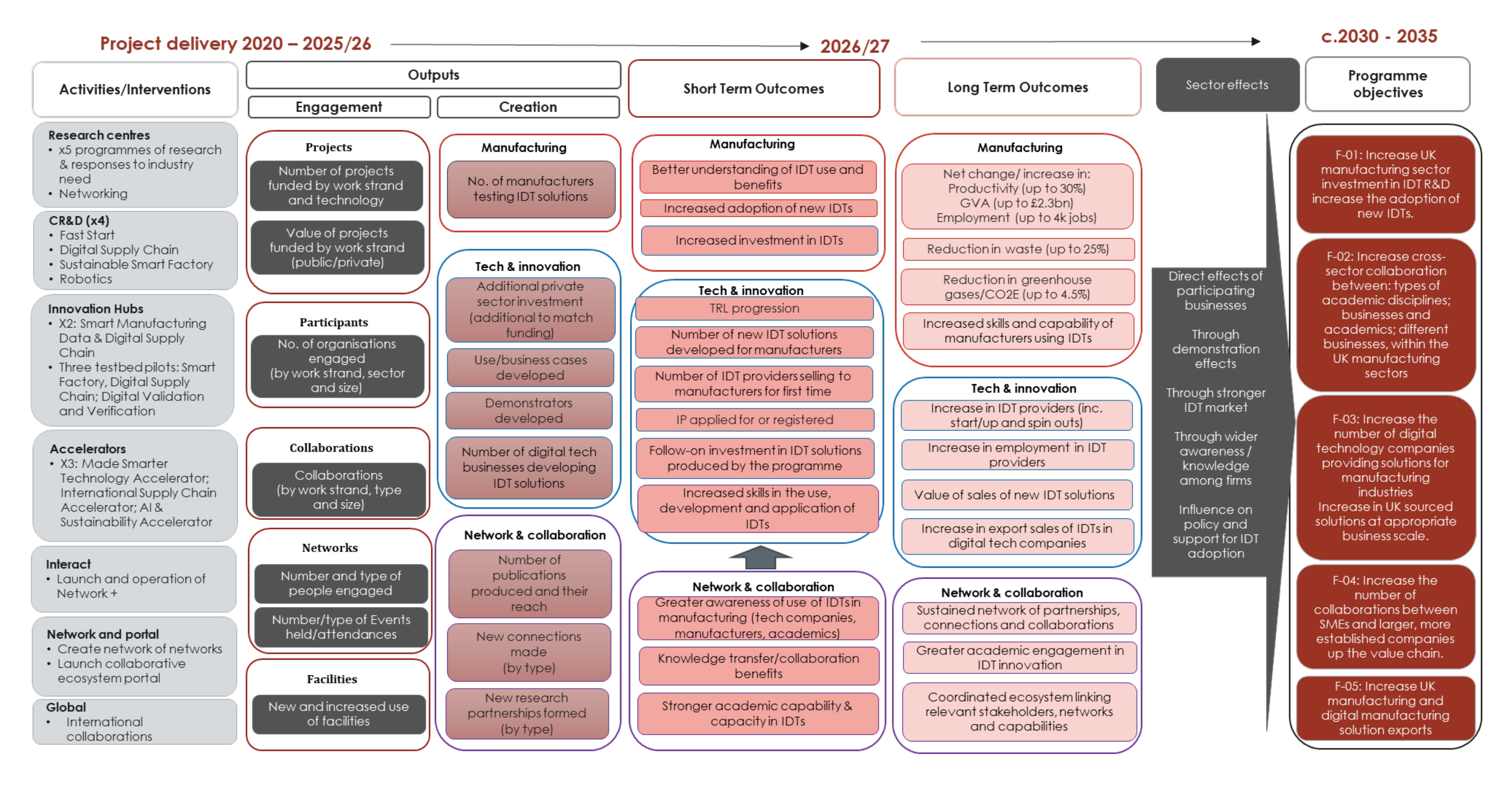
- **increase UK manufacturing sector investment** in industrial digitalisation R&D and **increase the adoption** of new Industrial Digital Technologies (IDTs)
- **increase cross-sector collaboration** between: types of academic disciplines, businesses and academics, and different businesses within the UK manufacturing sectors to avoid duplication and maximise IDT applications
- **increase the number of digital technology companies providing solutions** for manufacturing industries and providing UK sourced solutions at appropriate business scale
- **increase the number of collaborations** between SMEs and larger, more established companies up the value chain
- increase UK manufacturing and digital manufacturing solution exports, through demonstrable capabilities and products.

Logic model and theory of change

4.9 A logic model for the MSI programme is presented below in Figure 4-2. It describes the programme activities, outputs, and short and long-term outcomes to meet objectives.

[43] UKRI (2019) ISCF Manufacturing Made Smarter Challenge Business Case.

Figure 4-2: Made Smarter Innovation logic model



Source: SQW based on information from the Made Smarter Innovation Challenge

Theory of Change

Inputs and activities

4.10 MSI programme **inputs** are the resources (people, time, materials, funds, etc.) dedicated to its design and delivery. The key planned inputs include ISCF grant funding (£147m) and industry matched funding (£162m). There is further in-kind time, resource, expertise/knowledge contributions from the ISCF team, industry and academia. The programme delivery team is supported by wider UKRI support functions, as required. UKRI programme governance structures and support are available from the Challenge Advisory Group and Programme Board.

4.11 The programme was intended to deliver a suite of **activities** across seven workstreams relating to: funding industry-led innovation, university technology transfer, academic-led research, networking across manufacturing and digital technology sectors, and international collaboration. A summary of the workstreams and the associated activities is presented below.

Table 4-1: Summary of Challenge workstreams

Workstream	Summary	Lead partner	Planned funding
Collaborative Research and Development (CR&D)	Collaborative competitions to develop innovative IDT solutions. Bring together SMEs, large enterprises, and academic/RTO institutions to collaborate on applied research projects. Delivered through four competitions: Fast Start (CR&D1), Digital Supply Chain and Follow on (CR&D2), Sustainable Smart Factory (CR&D3) and Robotics (CR&D 4).	Innovate UK	ISCF funding: £62.39m Match funding: £82.3m
Innovation Hubs	Developing, demonstrating, and testing new solutions for digitising manufacturing functions. Delivered through two Innovation Hubs: Smart Manufacturing Data Hub (SMDH) and Digital Supply Chain Hub (DSCH), both of which ran grant funded projects and created a virtual platform offering access to resources. DSCH also ran test-bed projects and SMDH created a 'Manufacturing Data Exchange Platform' (MDEP), which enables companies to submit manufacturing data and receive insights in return.	Innovate UK	ISCF funding: £33m Match funding: £52m
InterAct (ESRC)	A social science research hub and multidisciplinary network to identify solutions to overcome barriers to the development and adoption of digital technologies.	Economic and Social Research Council (ESRC)	ISCF funding: £5m

Workstream	Summary	Lead partner	Planned funding
			Match funding: None
Research Centres (EPSRC)	Five Research Centres, each with a focus on key technological enablers for the manufacturing sectors: • Connected Factories • Cobotics • Digital Medicines Manufacturing (DM²) • Materials Made Smarter • People-Led Digitalisation	Engineering and Physical Sciences Research Council (EPSRC)	ISCF funding: £24.1m Match funding: £12m
Made Smarter Innovation Accelerators	To boost technology adoption and the acceleration of advanced digital technologies for UK manufacturing by bringing together large 'sponsor' companies with specific issues with SMEs to develop digital solutions: Three Accelerators planned: • Made Smarter Technology Accelerator • Sustainability Accelerator • International Supply Chain Accelerator	Innovate UK	ISCF funding: £6m Match funding: £6m
Made Smarter Innovation Network	Drawing on Innovate UK Business Connect's networks to facilitate cross-network engagement (cross sector and cross IDT). Supporting dissemination and engagement beyond the Challenge.	Portal: Innovate UK Network: Innovate UK Business Connect	ISCF funding: £1.5m Match funding: None
Global	Supporting companies to develop international relationships.	Innovate UK	ISCF funding: £5.9m Match funding: £10m

Source: SQW based on information from the Made Smarter Innovation Challenge.

Benefits

4.12 The programme's activities were intended to lead to **outputs,** as set out in the logic model above. The outputs can be grouped by engagement, demonstrating how much the Challenge has engaged with the sectors through, for example, projects, participants, collaboration, networks, facilities, and outputs created by Challenge activities such as digital tech firms developing IDT solutions and manufacturing firms testing IDT solutions.

4.13 There are various assumptions which underpin the delivery of outputs (see Annex Report):

- industry are willing to engage and able to coinvest
- applications are for high quality projects, with realistic, well-defined aims and objectives
- industry and academia have sufficient capacity (financial/time) to participate in project delivery.

4.14 The outputs for each of the workstreams are expected to translate into the **short-term outcomes** (manufacturing, tech and innovation, network and collaboration) as indicated in Figure 4-2, if the following assumptions hold:

- collaborative approach to projects leads to better designed IDT solutions
- projects are successfully able to prove/demonstrate viability and potential benefits of technologies/solutions
- businesses have capacity and capability to increase R&D and investment in new IDT solutions/technologies.

4.15 Further conditions need to hold true for short-term outcomes to translate into **longer-term outcomes** beyond the Challenge timeframe, including:

- new technology solutions are sufficiently substantive to make a real difference within participating firms (on productivity, GVA, employment, waste, CO_2e emissions)
- new digital manufacturing solutions are affordable and aligned to market need and demand
- digital tech companies have the capability and interest to pivot existing products or business models
- manufacturing businesses have the capacity and capability to adopt new IDTs and supply chain technology
- technologies are effective in reducing waste or CO_2e emissions.

4.16 It is important to note that some effects, such as employment and productivity, may be negative in the short-term whilst businesses implement new processes or if technology adoption leads to labour efficiencies.

Mechanisms

4.17 The key mechanisms expected to translate outputs into outcomes within the programme lifespan are:

- grant funding to de-risk and lever match funding for MSI project activities, and progress technologies sufficiently to de-risk follow-on investment or get them to market
- multi-disciplinary collaboration, including end-users, and a focus on integrated technologies, which lead to more innovative and fit-for-purpose technologies
- a systems approach involving actors across the value chain in collaborative R&D to provide routes to market, for example, key customers for the end product, intermediaries for key customers (e.g. via licensing), or (particularly in the Global strand) access to overseas markets
- effective knowledge exchange networks or diffusion mechanisms, and engagement with relevant actors (including intermediaries) to support demand-side awareness or uptake.

4.18 Over time, the following mechanisms lead to longer-term outcomes:

- business growth (IDT providers) as driven by direct sale of technology products, platform subscriptions, licensing and services – this includes new technologies taken to market or widening existing market reach
- business growth (manufacturers) as driven by improved processes or efficiencies made as a result of IDT adoption
- benefits to participating organisations as realised via a range of routes: validation of technologies at commercial scale, improved efficiency, increased viability of novel production systems, building market awareness or positioning, or more effective partnership working within projects.

4.19 A series of external drivers and factors that may influence the performance of the programme, including:

- national and global demand for IDTs / product trends (across different manufactured products)
- general labour and skills availability, as well as prices, exchange rates, profit margins in manufacturing / digital tech
- wider political, regulatory, economic drivers across the sectors.

5. Inputs and activities

Summary

- The MSI Challenge met or exceeded all activities and outputs targets except two, delivering a programme of considerable scale, breadth, diversity and ambition during a period of some economic and business disruption.
- The Challenge engaged a good number of SMEs (405 vs target of 200) and facilitated multiple collaborations across businesses by size (198 collaborations between SMEs and large companies) and type (185 collaborations between manufacturing firms and technology companies) and across business and academia (174 collaborations) in line with Challenge objectives, helping to directly address the market failure of poor communication between digital suppliers and manufacturers regarding market opportunities.
- The programme yielded a strong set of technology and innovation outputs in terms of technology solutions, demonstrators, use cases, and publications, underscored by strong investment levels from industry: companies invested almost £100m directly into Challenge activities against the £112m ISCF grant funding.
- On balance, stakeholders were satisfied that the Challenge was a "*sensible package*". In combination, the workstreams were understood to address the rationale and there was a sense of achievement in the scale and quality of delivery over five years, especially against the external challenges.
- The outputs give confidence that the Challenge made progress through the initial stages of the logic model via a well-executed tried and tested CR&D model but also by stimulating interest and engagement via more novel intervention models such as the Innovation Hubs. However, the delay in mobilising the Smart Manufacturing Data Hub has raised concerns that there was not enough time for this significant and novel intervention to reach its potential within the Challenge timeframe.
- Overall, the extent of outputs delivered provide confidence that the Challenge will generate outcomes, as described in the logic model.

5.1 This section sets out the inputs into the MSI Challenge, and the activities and outputs it delivered. The section draws primarily on the Challenge's monitoring data as well as consultations with Challenge stakeholders.

Inputs

5.2 **The Challenge managed its spending appropriately, disbursing £112m** (plus £5.79m operating expenditure, 5% of the Challenge's total value) across seven workstreams by programme close in March 2025 (Table 5-1). The figures in the table are correct as of March 2025.

5.3 The programme's original allocation of £147m, comprising £138m for delivery of seven workstreams and £9m for programme management and central operating costs, was revised down to £129m for workstreams due to wider Innovate UK spending pressures at the time of the Spending Review. The International workstream accounted for the largest proportion of this reduction (£5m) because the practical challenges of international collaboration in the context of the Covid-19 pandemic made initiating this workstream challenging at the time.

5.4 Three workstreams spent close to budget: InterAct, the Research Centres and the Network. International (as the Taiwan Globalstars project) spent close to its revised allocation. CR&D yielded a £7.58m underspend, 14% of its budget, where a small number of projects did not make as much progress as expected or were closed early and so did not draw down the funding. This level of underspend was slightly higher than the UKRI average of 5-8% for CR&D competitions but may indicate a slightly riskier portfolio to meet the Challenge's ambitions. Both the Innovation Hub and the Accelerator workstreams did not fully commit all their funds: the International Supply Chain Accelerator did not go ahead on the scale planned, instead being delivered via the £1m Impact Booster. Given funding rules and financial pressures within UKRI, it was not possible to re-purpose these funds.

5.5 UKRI was not the only source of investment in the Challenge. There was substantial investment from the private sector and a smaller proportion from other public sources, notably in the CR&D projects, the Innovation Hubs and the Research Centres. The £100m total private investment is less than the original £162m target for match funding but is almost 90% of the £112m actual spend on Challenge activity. UKRI classifies investment based on four 'Forms':

- Form 1 is contractual spending on a UKRI project
- Form 2 is additional but non-contractual investment on a UKRI project
- Form 3 is investment in an aligned or related area, where UKRI funded activity has increased confidence
- Form 4 is subsequent or follow-on investment to further develop or exploit outcomes from a UKRI project.

5.6 These Forms of investment can also be divided into public and private sources. The 'Other investment' in Table 5-1 only includes Forms 1 and 2 investment i.e. funding directly related to the MSI activities in question.

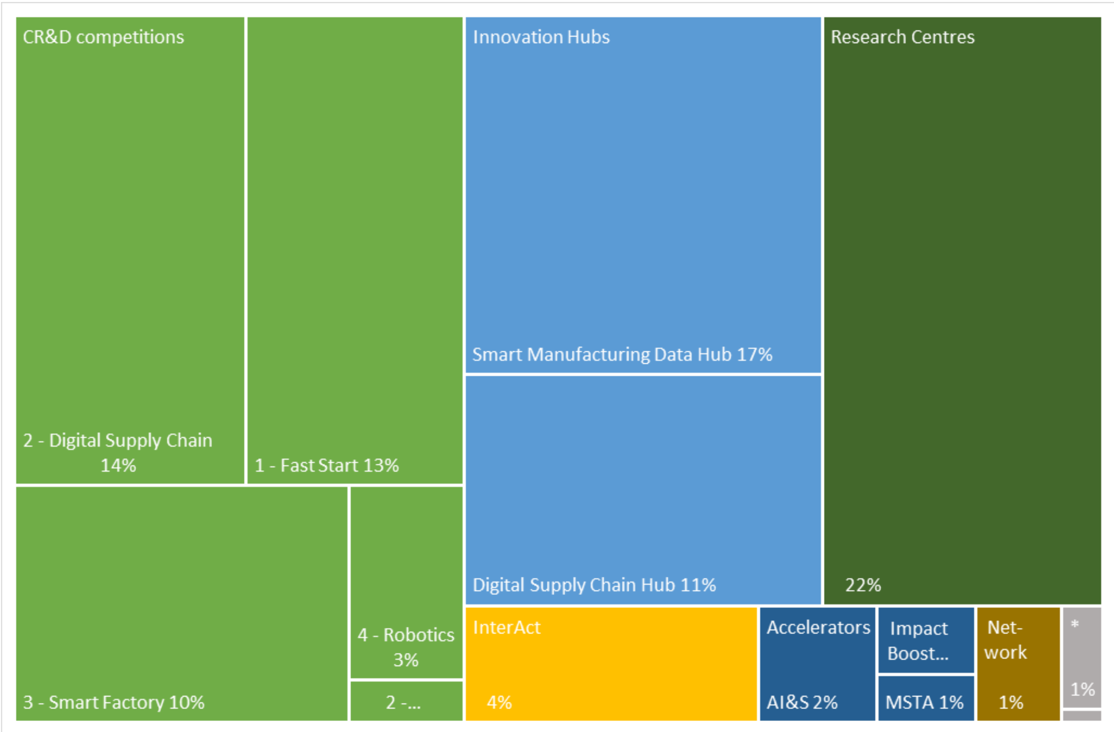
Table 5-1: Challenge funding

Workstream	Budget £m	Amount spent £m	Amount spent vs budget £m	Other investment £m
CR&D	53.72	46.14	-7.58	52.85
CR&D 1 - Fast Start	*17.30*	*14.88*	*-2.42*	*25.13*
CR&D 2 - Digital Supply Chain	*17.85*	*15.78*	*-2.07*	*12.64*
CR&D 2 - Follow on	*0.81*	*0.70*	*-0.11*	*1.2*
CR&D3 – Sustainable Smart Factory	*13.72*	*11.51*	*-2.20*	*11*
CR&D4 - Robotics	*4.04*	*3.27*	*-0.77*	*2.92*
Hubs	35.96	30.63	-5.34	45.47**
Digital Supply Chain Hub	*12.23*	*11.97*	*-0.26*	*12.85*
Smart Manufacturing Data Hub	*23.74*	*18.66*	*-5.08*	*31.87*
InterAct	5.00	4.99	-0.01	0
Research Centres	24.09	24.01	-0.08	11.53
Accelerators	7.61	3.68	-3.93	1
Made Smarter Technology Accelerator	*1.00*	*0.68*	*-0.32*	*1*
International Supply Chain Accelerator	*3.61*	*-*	*3.61*	*0*
Sustainability Accelerator	*2.00*	*2.00*	*0.00*	*0*
Impact Booster	*1.00*	*1.00*	*0.00*	*0*
Network	1.50	1.45	-0.05	0.73
International	0.87	0.63	-0.24	0.45
Standards and Regulations*	0.25	0.08	-0.17	0
			Total private investment	**99.67**
			Total public investment	**12.36**
Total	**129.0**	**111.61**	**-17.39**	**112**

*Source: SQW based on information from the Made Smarter Innovation Challenge provided in March 2025. Figures may change slightly as MSI completes final programme accounting. Note, pink rows indicate key workstream totals. *Standards and Regulation was a small piece of work that did not sit within any of the core workstreams. **Includes £0.75m for the Hub pilots*

5.7 The CR&D competitions represented the largest proportion of the Challenge spend, followed by the Innovation Hubs (combined) and the Research Centres (Figure 5-1). The other workstreams comprised only 10% of the total workstream spending. InterAct's funding was similar to each of the five Research Centres, which received around £5m each.

Figure 5-1: Challenge workstream funding



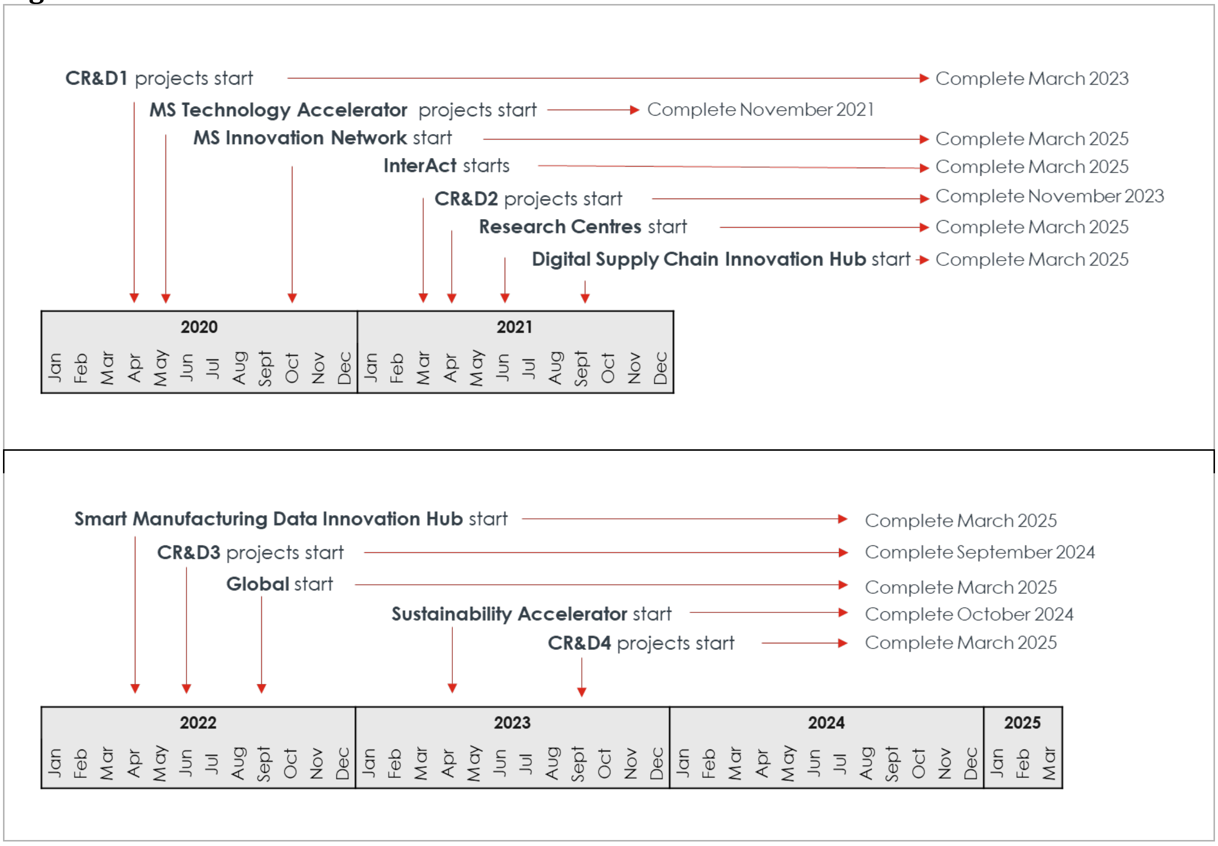
Source: SQW based on information from the Made Smarter Innovation Challenge. Note, the light grey box represents International and Standards & Regulations

Activities and outputs

5.8 Despite mobilising during the upheaval of the Covid-19 pandemic, **the Challenge largely delivered on its workplan by the planned closure in March 2025** (Figure 5-2).[44] There were delays during delivery: notably the Smart Manufacturing Data Hub was slow to mobilise due to contractual issues, the late withdrawal of a consortium member, and a longer than anticipated competition process; the Research Centres took time to ramp up delivery because of slow university-based recruitment and, as a result, remained at risk of underspend throughout; and the MSI Network experienced a lull in 2022/23 due to personnel issues that reduced its capacity. The programme team also operated at reduced staffing levels for considerable periods, including when the original Challenge Director left. This is shown in the significant opex underspend.

[44] Funding in the Autumn 2024 Budget was awarded to support some of Made Smarter Innovation's investments after the closure of the Challenge. How the money will be spent was not confirmed at time of writing.

Figure 5-2: MSI workstream timeframe



Source: SQW based on information from the Made Smarter Innovation Challenge

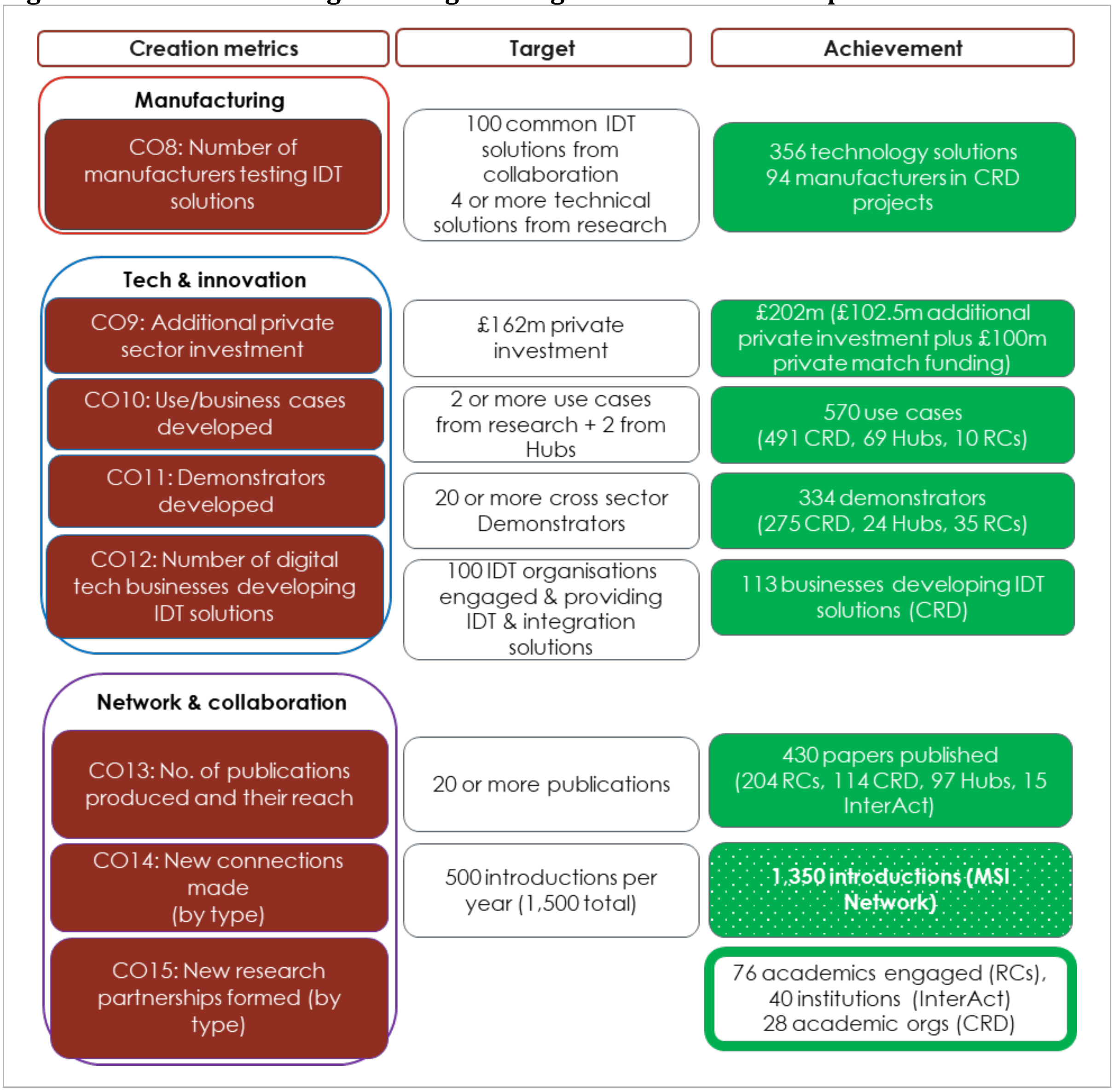
5.9 **Across the programme, a wide range of activities and outputs were delivered and the Challenge met its key output targets** although it did not quite achieve a 50:50 match funding ratio, achieving £100m in private sector investment on projects against the £112m MSI investment. In Figure 5-3 and Figure 5-4, we present performance against output targets initially set alongside the development of the Challenge business case (a solid green box indicates target achieved or exceeded, a green border indicates achievement where no target was set, a patterned green box indicates progress but shortfall against target). Subsequently, we present outputs by workstream.

Figure 5-3: Achievement against target on logic model engagement output metrics

Engagement metrics	Target	Achievement
Projects		
CO1: No. of projects funded by work strand/ technology		76 CRD projects: 49 AI/data analytics; 28 IoT; 16 Robotics; 8 AM; 1 XR; 31 digital twin
CO2: Value of projects funded by work strand (public/ private)	50:50 UKRI to private investment ratio	**£111.6m ISCF £100m private investment (90% of target)**
Participants		
CO3: No. of organisations engaged	200 SMEs engaged & collaborating with larger, more established companies	405 SMEs: 138 CRD; 168 Hubs; 99 RCs
Collaborations		
CO4: Collaborations (by work strand, type and size)	>20 collaborations of at least two different research disciplines	894 collaborations between CRD partners; 107 MSIN collaborations; 30 RC collaborative projects
Networks		
CO5: Number and type of people engaged		10,540 links clicked in email newsletter
Facilities		
CO6: Number/ type of Events held/ attendances	5+ events arranged 10 events attended as speakers	61 events held by MSI Network, 92 by RCs, 35 by InterAct; 25 events spoken at (MSIN)
CO7: New and increased use of facilities		No data

Source: SQW based on information from the Made Smarter Innovation Challenge. All data from programme monitoring. Final figures reported by the programme may be higher as workstreams continued to report outputs after evaluation analysis. Note, private investment comprises contractual investment by companies into projects ('Form 1' in UKRI terminology) and additional but non-contractual investment on projects ('Form 2'). CO3, number of organisations engaged is likely to be an underestimate as not all engagements, especially with SMEs, are likely to be recorded across all workstreams e.g. any engagements InterAct has with SMEs is not included here.

Figure 5-4: Achievement against target on logic model creation output metrics



Source: SQW based on information from the Made Smarter Innovation Challenge. All data from programme monitoring. Final figures reported by the programme may be higher as workstreams continued to report outputs after evaluation analysis.

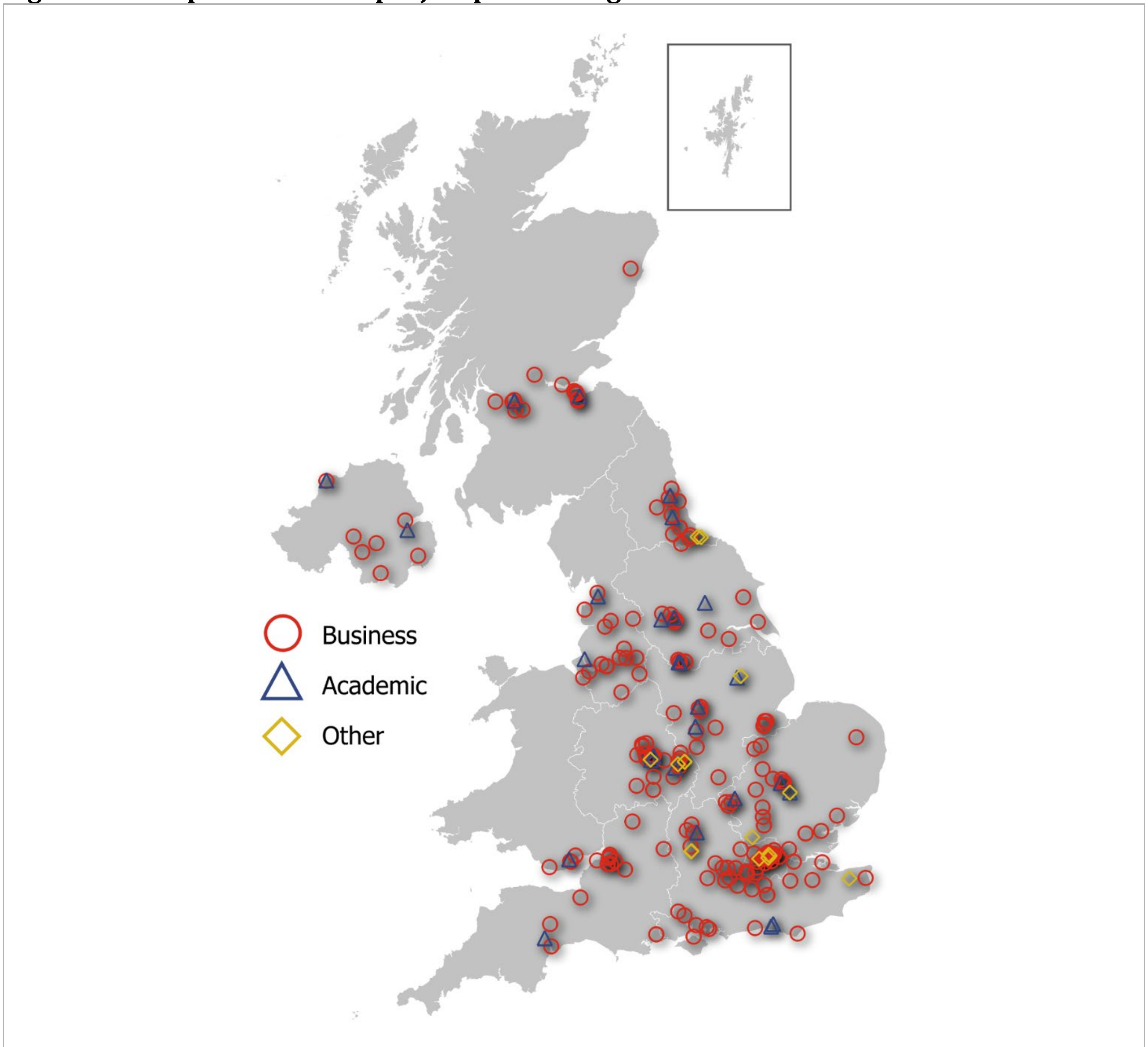
CR&D

5.10 CR&D represented the largest funded workstream. Over five years four competitions (five if CR&D 2 and CR&D 2 Follow on are counted separately) were delivered totalling 76 funded CR&D projects that involved 272 unique partners. Half of the organisations (138) were SMEs, which was under the target of 200 SMEs but the other workstreams also engaged with and funded SMEs (for example, the Innovation Hubs engaged 168 SMEs) helping the Challenge to meet this target. Nearly a third of CR&D partners (29%, 79) were large businesses, 10% were academic organisations with the remainder being RTOs or other public sector organisations.

5.11 **CR&D project partners were an even mix of digital technology companies and manufacturers**: 43% had Information and Communication or Professional, Scientific and Technical activities as their primary SIC code and 40% had Manufacturing as their primary SIC code. **Among the CR&D projects there were 894 collaborations** (the number of unique pairings in each project e.g. if a project had four partners, there were six collaborations). Of these, **there were 198 collaborations between SMEs and large companies, 185 collaborations between manufacturing firms and technology companies,**[45] **and 174 collaborations between businesses and academics/research organisations**. There were no targets for these collaborations but cross-sector collaboration and collaboration between businesses of different sizes were objectives for the Challenge.

5.12 There was a reasonable geographic spread of partner organisations (Figure 5-5) although there was a higher proportion of firms with a postcode for London or the South East. Wales had the lowest level of engagement with only 2% of beneficiaries located there.[46]

Figure 5-5: Map of MSI CR&D project partner organisations



Source: SQW based on information from the Made Smarter Innovation Challenge.

[45] The SIC codes 'Information and Communication' and 'Professional, Scientific and Technical activities' were used as a proxy for technology companies

[46] Note the maps in Figure 5-5 and Figure 8-2 are based on different populations. The first covers all beneficiaries. The second includes only beneficiaries that had a Beauhurst record.

5.13 CR&D projects are monitored through regular meetings with monitoring officers who score progress from 1 (immediate barriers preventing progress) to 5 (full progress, no reported barriers) on a range of categories. Overall, projects performed reasonably well, with the average score across all categories being 3.5.

5.14 **The spread of technology focus was fairly diverse but more weighted to data than physical technologies like robotics and AM.** Notably, the second most common technology after AI/data analytics was Digital Twins, which was not one of the five focus IDTs. Only one project focused on XR (extended reality). Again, there was no target for cross-sector collaboration but it was a Challenge objective. Excluding the CR&D2 Digital Supply Chain feasibility studies, there were:

- 49 projects related to AI/machine learning (38) and/or data analytics (11)
- 31 projects related to digital twins
- 28 projects related to IoT
- 16 projects related to robotics
- 8 projects related to additive manufacturing
- 6 projects related to distributed ledger technology (including blockchain)
- 1 project related to extended reality (augmented reality/virtual reality/mixed reality).

5.15 The CR&D projects significantly exceeded target on a number of key outputs (Figure 5-4):

- 178 new technology solutions against target of 100
- 275 demonstrators against a target of 20
- 491 use cases against a target of 2
- 114 papers published/presented
- 9 new standards developed
- 79 new business models developed.

Innovation Hubs

5.16 The Digital Supply Chain Hub and the Smart Manufacturing Data Hub were a new model of intervention. Each was tendered and awarded to a consortium, the former led by the Digital Catapult and the latter by the University of Ulster. The Hubs were intended to bring together capabilities and (existing) facilities and deliver projects to support the development of IDTs. The Digital Supply Chain focused on improving information flows across supply chains to reduce waste and improve productivity. The Smart Manufacturing Data Hub aimed to support manufacturing firms, especially SMEs, to extract more insight and value from data to improve efficiency and productivity, and reduce waste.

5.17 Together, the Hubs achieved a similar scale of engagement as the CR&D competitions, engaging 317 organisations, just over half of which were SMEs (53%, 168), 28% were large companies, and 195 were academic organisations. The Hubs helped the Challenge exceed the overall programme output targets, with an additional 24 demonstrators, and 69 use cases, 97 papers published/presented, and seven new standards developed.

Research Centres and InterAct

5.18 The Research Centres supported digitalisation in manufacturing at an earlier stage of the innovation process i.e. lower TRLs. Evidence of the outputs delivered by these strands therefore concerns the extent to which they have engaged with and brought together industry and academia, as well as some early innovation outputs.

5.19 **Collectively, the Research Centres exceeded the research outputs targets.** Against a target of a minimum of 20 collaborations of at least two different research disciplines.

- 76 academics (from outside their own consortia) were engaged
- 74 technology businesses and 84 manufacturing businesses were engaged
  - of these 158 firms, 99 were SMEs
- 204 papers were published or presented against a target of a minimum of 20
- 92 events were delivered against a target of five (at which there were nearly 14k attendees).

5.20 InterAct contributed to MSI by facilitating collaboration between academia and industry as well as facilitating relevant economic and social research. InterAct also supplemented the outputs achieved by the Research Centres by organising the involvement of 40 institutions across 27 funded projects, funding of 51 Fellowships, holding 35 events (at which there were 1,095 attendees) and producing 15 publications. It also generated engagement in terms of 722 new registrations for newsletters and email updates.

5.21 The Research Centres also contributed to the technology outputs: across their projects, 10 use/business cases have been developed and 35 demonstrators created.

5.22 The overachievement against targets indicates that, as with the CR&D workstream, **the Research Centres, were more productive than anticipated**, despite their slow start.

Accelerators

5.23 Three Accelerators were delivered. These were relatively small in terms of funding compared to the CR&D competitions. The model involved large companies setting technology challenges against which smaller digital technology companies then bid to develop solutions. Reporting for the first two Accelerators (the third was ongoing at the time of writing) show that they generated 28 prototypes and 8 MVPs (minimum viable products). Between them they also produced eight demonstrators and 22 use cases.

MSI Network

5.24 The MSI Network aimed to support and amplify the work undertaken by other workstreams. **The Network had its own KPIs, against which it over-delivered**: it had 25 speaking opportunities against a target of 12, hosted 61 events against a KPI of 42, generated 107 collaborations against a target of 98, made 1,350 introductions against a KPI of 1,108 and recorded 15,347 clicks on a newsletter link against a KPI of 3,595. At the time of writing, the Network was slightly short against the KPI of 45 case studies, having produced 42 to raise awareness of the Challenge's work. Thus, the Network also outperformed expectations, even with the disruption caused by turnover in personnel.

Investment

5.25 The Challenge also stimulated additional private sector investment (beyond match funding or Forms 1 and 2 investment) of £102m across CR&D, the Research Centres and the Hubs. This investment was for activity following on from projects funded by the Challenge (in UKRI terminology, Forms 3 and 4 investment for adjacent or follow-on activities). **In total, private match funding plus additional follow on private sector investment amounted to £202m, exceeding the private investment target of £162m.**[47]

Reflections from stakeholders

5.26 Overall, stakeholders consulted were satisfied that the Challenge had been well-designed and delivered, as evidenced by the scale of outputs coming through in the final few months. The Challenge was seen as an ambitious programme, with only £138m (excluding opex), revised to £129m, allocated to support a manufacturing sector of c.270k firms. Delivery proved hard from the outset, with the Challenge mobilising during the Covid-19 pandemic in 2020/21, and having to deal with additional issues such as the consequences from the UK's withdrawal from the EU and the war in Ukraine, including supply chain issues and the steep increase in energy costs.

5.27 Yet, there was a broad consensus that **the significant investment in the CR&D competitions had been spent effectively**. There had been good engagement from both the manufacturing and digital technology sectors in the CR&D competitions, as evidenced by the even split in

[47] Figures correct as of March 2025. Value of follow-on investment (Forms 3 and 4) may increase over time as companies commit additional funds.

participants. All competitions had received sufficient good quality applications to award the majority of the funding and only a small number of projects were withdrawn or terminated for specific reasons. An underspend on the earlier competitions meant it was possible to include a fourth competition. CR&D 1 had the broadest scope; a piece of work by the Challenge team on technology and sustainability helped to refine the scope of subsequent competitions to maximise the likelihood of high quality, eligible applications and to improve alignment with the technology strategy.

5.28 It was acknowledged that **the CR&D workstream benefitted from the fact there was a standard UKRI model to follow** with processes in place to facilitate the design and delivery of CR&D competitions. This was backed up with evidence from CR&D respondents to the survey, with project management and monitoring processes (including auditing), and good levels of support from MSI staff, as well as project partners, felt to be important factors in successful project delivery.

"Support from monitoring officer from my point of view was very helpful. My job was to keep track and monitor the financial side of it so it was support for that process. We're a smaller partner so having a project lead from a larger company who collaborated and had previous experience [of UKRI/IUK funding]."

MSI beneficiary survey respondent

5.29 It is worth noting that a small number of survey respondents reported that limited CR&D funding flexibility and time consuming programme processes were felt to hinder project delivery, along with factors outside of the programme's control, such as project partners withdrawing from the project.

"We were a little late to the project which meant that it was all a bit rushed. In an ideal world we would have started sooner. It would have been better if we could have extended it a little bit."

MSI beneficiary survey respondent

5.30 Stakeholder reflections on the Innovation Hubs were more nuanced. **There was general acknowledgement that both Hubs had largely managed to deliver on their plans.** The Digital Supply Chain Hub, as the smaller, more focused initiative, with an experienced consortium and strong governance, successfully delivered the package of interventions, including flagships to boost existing expertise and create regional centres of excellence, open calls and test-beds to support new projects and collaborations, and a Virtual Hub that brought together manufacturers to share knowledge and promote adoption of supply chain solutions. The Digital Supply Chain Hub did experience contracting issues on projects with multiple partners but with additional resource was largely able to overcome these.

5.31 The larger, more complex and ambitious Smart Manufacturing Data Hub experienced more significant issues in terms of contracting between the consortium and UKRI, which delayed the launch of the Hub by a year. The Hub lead was also less experienced than the DSCH's counterpart lead at leading such an intervention and recruitment to key roles took longer than expected. Ultimately, **the Smart Manufacturing Data Hub delivered its core outputs but the reduced timeline means that the most novel and potentially influential intervention, the Manufacturing Data Exchange Platform (MDEP), did not run as long as expected.** Despite early challenges with industry engagement, increasing interaction from SMEs with the MDEP meant stakeholders are keen for to maintain investment in the Hub in order to maximise its value.

5.32 **The Research Centres are broadly viewed as an interesting and useful element of the Challenge by stakeholders. The Research Centres delivered the volume of events and publications that was planned despite mobilisation taking time because of delays in university recruitment.** The alignment of research with industry priorities and the range of activity types was credited with ensuring good levels of industry engagement.

5.33 **InterAct was similarly viewed as a well-considered intervention for the Challenge**, that complemented other elements by effectively bridging industry and academia through targeted funding that **addressed gaps between academic research and industry need.**

Case Study – InterAct and Adey Steel

InterAct collaborated with Circular Metals, and Adey Steel on a project to develop a business model based on circular economy principles. The project involved: developing an understanding of Adey Steel's business processes and supply chain; exploring the identified product (smart motorway gantries); and developing options for a future business model.

Adey Steel reported they are not likely to adopt the circular business model for gantry production in the short-term because of the substantial upfront investment but the plan was seen to be more viable over the next 5-10 years, depending on a number of factors e.g. transport infrastructure policy, customer interest and availability of investment funds.

Adey Steel has benefited from new insight for their business and strengthened relationships with two universities. There is a tangible output for the manufacturing sector in terms of resources developed by InterAct, including a six-step guide on developing alternative business models and an online tool about supply chain and product design principles.

The benefits outlined above would not have been achieved without InterAct. InterAct had done prior research that this project built on and used its network to bring together the necessary partners and expertise. This bringing together of partners was seen to be an important aspect of InterAct's work and how it generates benefits.

5.34 The Accelerators were seen as a useful additional element to the Challenge in providing a different route to stimulating innovation between digital technology firms and manufacturers.

The high level of interest was seen as an endorsement of the approach from industry. The Accelerators delivered the prototypes and MVPs as planned.

5.35 **The MSI Network broadly delivered on outputs in terms of engaging industry.** The Network was hampered by personnel and organisational changes, delays in workstream delivery as well as a preference among some initiatives to deliver their own communications, for example via newsletters. Ultimately, it was seen as important for the Challenge to utilise Innovate UK Business Connect's existing links into industry and there is a view that in the final year the Network did support the Challenge to showcase outputs.

5.36 **On balance, stakeholders were satisfied that the Challenge was a "*sensible package*".** In combination, the workstreams were understood to address the rationale and there was a sense of achievement in the scale and quality of delivery over five years, especially against the external challenges. There was a recognition of the value of using tried and tested models such as CR&D to deliver scale and breadth of innovation support. But there was greater interest in and expectation of the novel approaches of the Hubs and the Research Centres, particularly the inclusion of a social sciences angle. A small number of stakeholders did express concern that the scale and diversity of the Challenge, as well as inclusion of novel initiatives such as the Innovation Hubs, may have put undue pressure on the (under-staffed) Challenge programme team to mobilise delivery, coordinate and manage multiple workstreams, and that a more focused approach would have been more efficient and effective.

Progress against programme logic model

5.37 The MSI Challenge met or exceeded nearly all activities and outputs targets (achieving private investment match funding of 90% of MSI grant spend and reaching 1,350 introductions in four years against a target of 500 per year) delivering a programme of considerable scale, breadth, diversity and ambition during a period of some economic and business disruption. The Challenge engaged over 400 SMEs[48] and facilitated significant numbers of collaborations across manufacturing and digital technologies, directly addressing the issue of poor communication between digital suppliers and manufacturers regarding market opportunities. The programme yielded a strong set of technology and innovation outputs in terms of solutions, demonstrators, use cases, and publications, underscored by strong investment levels from industry.

5.38 The outputs give confidence that the Challenge made progress through the initial stages of the logic model via a well-executed, tried and tested CR&D model but also by stimulating interest and engagement via more novel intervention models, namely the Innovation Hubs and the Research Centres. However, the delay in mobilising the Smart Manufacturing Data Hub has raised concern that there was not enough time for this significant and novel intervention to reach its potential within the Challenge timeframe. Delays in recruitment for the Research Centres may also have

[48] 138 via CR&D, 168 via Hubs, 99 via Research Hubs.

reduced the outputs they have been able to generate. Overall, the extent of outputs delivered provide confidence that the Challenge will generate outcomes, as described in the logic model.

6. Outcomes and impacts

Summary

- MSI has contributed towards all the short-term outcomes identified in the programme's logic model. There were fewer programme-level targets set for these outcomes than there were for outputs so progress is assessed by weight and quality of evidence.
- The beneficiary survey revealed the following achievements:
  - most respondents (35/43, 81%) felt that participation in MSI had led to **increased understanding of the application of IDTs**
  - more than half (18 out of 33) of respondents indicated that their **technology had progressed by at least three TRLs**
  - two-fifths (10/25) of respondents identified **additional financial investment in their project (CR&D or Innovation-Hub supported project)**
  - three-quarters (33/43) of respondents indicated that **individuals within their organisation had acquired new skills** due to the project.
  - more than half (26/43) respondents had achieved an **increase in jobs, turnover or productivity**, as a result of MSI-funded projects.
- According to programme monitoring data:
  - **601 businesses adopted innovative digital solutions**
  - **15 spin-outs or start-ups were created through MSI activities**.
- Evidence from the beneficiary survey, consultations with Challenge stakeholders and delivery team, and beneficiary case studies, suggests that **grant-funding and collaboration** have been important change mechanisms, helping activities and outputs to translate into short-term outcomes.
- There are early signs that these short term outcomes are starting to translate into longer-term outcomes, such as productivity improvements and increased employment, as described in the programme logic model (note the longer-term outcomes are not anticipated until 2026/27 and beyond, following the programme and evaluation).

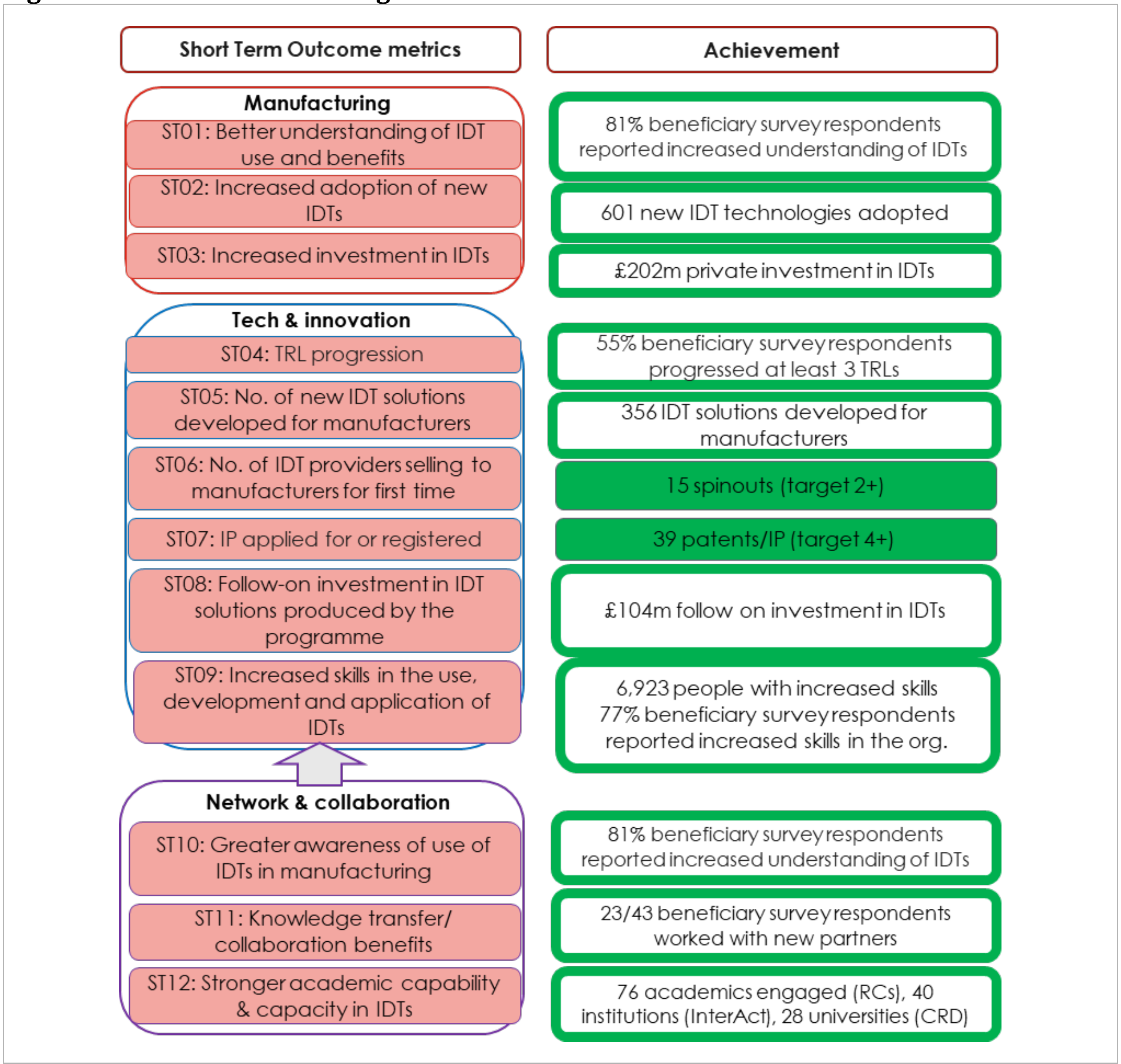
6.1 This section sets out the performance of the Challenge in terms of outcomes and impacts. The section draws on several strands of evidence including: a survey of beneficiaries; a survey of unsuccessful applicants; consultations with internal and external stakeholders; case studies; and Challenge monitoring data.

Short-term outcomes

Overall achievement of outcomes

6.2 MSI has contributed towards all of the short-term outcomes identified in the programme's logic model, including increased awareness and understanding, innovation, adoption, investment and skills (Figure 6-1). There were fewer programme-level targets set for these outcomes than there were for outputs so progress is assessed by weight and quality of evidence (solid green boxes indicate target achieved or exceeded; green border only indicates achievement where no target was set). Additional detail on outcomes is provided below the graphic.

Figure 6-1: Achievement on logic model short-term outcome metrics



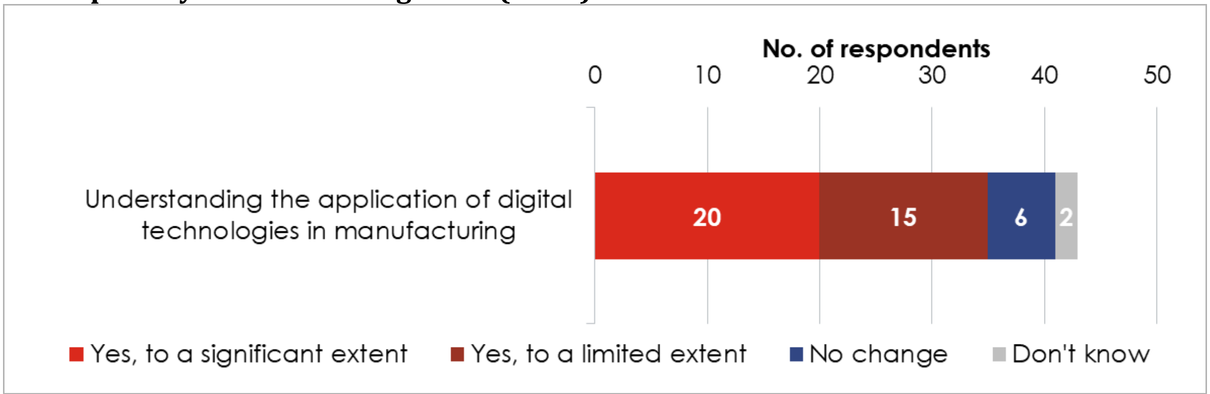
Source: SQW based on information from the Made Smarter Innovation Challenge programme monitoring data and analysis of the beneficiary and unsuccessful applicant surveys. Final monitoring data figures reported by the programme may be higher as workstreams continued to report outcomes after evaluation analysis.

Achievement on awareness and understanding outcomes

STO1: Better understanding of IDT use and benefits, ST10: Greater awareness of use of IDTs in manufacturing

6.3 **MSI has contributed towards better understanding of IDT use and its benefits within UK manufacturing**. Evidence from the beneficiary survey showed most respondents (81%) felt that participation in MSI had led to increased understanding of the application of IDTs in manufacturing, and for half of these this was felt to have been to a significant extent (Figure 6-2).

Figure 6-2: Has engaging in the project raised your organisations' understanding, skills and capability in the following area? (n=43)



Source: SQW analysis of beneficiary survey data

6.4 Improving understanding as to the potential uses and benefits of IDTs is an important element of increased IDT adoption and lays the foundations for continued IDT uptake beyond the programme period. External consultees commented on the work done by the MSI programme to raise the profile of IDT solutions and their application to manufacturing.

"MSI demonstrates really good use cases around time to market, reduced costs, and increased productivity.[...] The visibility of digital technologies, and the potential benefits to the UK have been highlighted through the programme."

External consultee

6.5 One example of work undertaken to increase understanding of the application of IDTs was the Digital Medicines Manufacturing (DM^2) Research Centre's collaboration between the University of Strathclyde and the Glasgow School of Art (GSA) to develop applications using Extended Reality (XR) technologies in pharmaceutical manufacturing. The apps have been used by researchers and students within laboratories to demonstrate how XR technologies can add value to manufacturing processes. Immersive training modules using XR have also been developed, which launched via the SkillsFactory in Spring 2025.[49] These training modules will be accessible to students and industry partners, helping to raise awareness of the benefits of immersive training.

[49] https://cmac.ac.uk/skills-factory

6.6 **MSI has also increased awareness of IDTs within UK manufacturing.** A number of Challenge initiatives were about engaging firms with limited knowledge and awareness of IDTs. For example, the Smart Manufacturing Data Hub employed business advisors to reach out to the SME manufacturing population in order to raise their awareness of how data analytics could benefit their businesses. There is evidence that MSI has raised awareness. For example, four beneficiary survey respondents reported that they had not considered their proposed project until the MSI Challenge, suggesting that MSI had stimulated interest in the use of IDTs. All four of these were industry partners: three were digital technology developers and one was a manufacturer.

6.7 Case study evidence illustrates how Challenge activity has raised awareness. The OMNIFactory®, part of the Connected Factories Research Centre led by the Universities of Nottingham, Sheffield, and Cambridge, aimed to demonstrate how IDTs can create flexible, reconfigurable manufacturing systems. It served as a national test bed for digitally enabled manufacturing through various research projects. The focus on industry engagement by OMNIFactory® has meant that a number of businesses have been exposed to ideas about how IDTs can benefit their businesses and have taken ideas from the OMNIFactory® and applied them, either with the support of the OMNIFactory® team or on their own. This stimulation of new projects through raising awareness and knowledge exchange is one of the key outcomes of the OMNIFactory®. More detail on OMNIFactory® can be found in the Annex Report.

Achievement on innovation outcomes

STO4: TRL progression

6.8 **The Challenge supported innovation as measured by progress on Technology Readiness Levels** (TRLs – a systematic metric used to assess the maturity of a particular technology, which range from 1 'basic principles observed and reported' to 9 'product/service on commercial release/process deployed').

6.9 A key route to TRL progression was through funding CR&D projects. Nearly all beneficiary survey respondents reported that their technology had advanced to a higher TRL due to their MSI-funded project. **More than half (18 out of 33) of the respondents indicated that their technology had progressed by at least three TRLs**, and nearly a half (15 out of 33) were able to reach deployment stages (TRL 7-9). Three respondents mentioned that their technology either stayed at the same TRL or regressed but a degree of mixed performance is expected in an innovation portfolio as an indication that risks have been taken (Figure 6-3; the darker green squares indicate greater TRL progression; grey squares represent no change in TRL; light pink represents TRL regression).

Figure 6-3: TRL progression of MSI-funded projects (n=33)

	Current TRL								
TRL prior to MSI application	1	2	3	4	5	6	7	8	9
1 Basic Principles				4		1		4	2
2 Developing hypothesis			1	1					
3 Specifying and developing PoC				2			3	1	1
4 PoC demonstrated in test site	1			1	3	1			
5 Validated in relevant environment								1	1
6 Validated in operational environment						2	1		
7 System complete and qualified									
8 Product/technology being implemented									1
9 Product/service on commercial release/ process deployed									1

Source: SQW analysis of beneficiary survey data

6.10 The survey data were supported by case study evidence that illustrates in more detail how MSI activities have contributed towards the progression of multiple technologies. For instance, the Smart Pharma Supply Chain project led by GlaxoSmithKline aimed to automate a key process in the pharmaceutical manufacturing supply chain, the evaluation of in-bound material quality certification, using digital technologies within the pharmaceutical supply chain. The project moved from exploratory investigation, through to Proof of Concept, and to a Minimum Viable Product which underwent testing with real-world suppliers.

ST07: IP applied for or registered; STO5: Number of new IDT solutions developed for manufacturers

6.11 MSI also demonstrated successful support for innovation through progress on two other indicators. **First, there is evidence of the creation of Intellectual Property (IP), especially through CR&D projects**. Monitoring data indicates that 39 IP applications have been made related to MSI-funded projects, with most stemming from CR&D projects. From the relatively small survey sample, two beneficiary survey respondents reported having registered IP, and four others anticipated registering IP in the future. It is worth noting that not all firms will apply to register their IP, preferring commercial secrecy, and many process innovations are not easily captured by a patent.

6.12 **Second, MSI has contributed to the increased availability of IDT solutions for UK manufacturers**. The monitoring data shows that through CR&D, the Innovation Hubs and Research Centres, 356 IDT solutions were developed for manufacturers. This is supported by data from the beneficiary survey data that show MSI-funded projects led to the development of 35 technology solutions across 16 project leads (out of 25 respondents). Among these, 14 respondents had tested the technologies with manufacturing businesses, and in two cases, the technologies were tested with over 10 manufacturers. Moreover, six survey respondents indicated that they expect new technology solutions to be developed in future. A fifth (8/40) of survey respondents reported that the MSI-funded project had already led to the launch of a commercially available product/service in the market (and therefore available to manufacturers), and a half (20/43) expected their project to result in the launch of new products/services within the next three years.

6.13 The case study evidence illustrates how the programme facilitated technological progression of IDT solutions for manufacturers. A collaborative project delivered through the Digital Supply Chain Hub (DSCH) involved a partnership between Singular Intelligence (an AI start-up), Sainsbury's supermarket and Cranswick (a food producer). Fluctuations in consumer demand for pork combined with labour shortages at farms and slaughterhouses meant Cranswick had to contend with oversupply and under-supply at different times and Sainsburys was faced with food waste and revenue loss. The partners investigated how AI and digital technologies could be used to improve supply and demand imbalances by improving forecasting and planning decisions at different levels of the supply chain. An AI solution was developed to interpret market signals and mitigate the risk of supply-demand imbalances, progressing the solution from TRL 4 (proof of concept) to TRL 7 (system validated). The prototype was tested in an operational environment and the pilot resulted in a 70% reduction in the supply-demand imbalance overall, leading to less waste, better quality control and improved product availability.

Achievement on adoption outcomes

STO2: Increased adoption of new IDTs

6.14 **The MSI programme has encouraged adoption of IDTs among programme participants.** Programme monitoring data records 601 businesses as having adopted innovative digital solutions. External consultees considered that MSI has led to adoption of technologies within specific settings and for specific processes but were more cautious about the influence of the programme in delivering widespread adoption of IDTs. A few consultees highlighted that adoption of IDTs was limited given the scale of the manufacturing sector. They noted significant external barriers to adoption, including lower than anticipated digital maturity in the manufacturing sector, particularly among SMEs, which has hindered the programme's ability to engage with more companies. It was also noted that sector-wide adoption of IDTs was the responsibility of the Made Smarter Adoption programme.

6.15 Case study material provides instructive examples of how the MSI programme has contributed towards increased adoption of IDTs by participating manufacturers.

Case study - increased adoption of new IDTs

Two case studies involving the Smart Manufacturing Data Hub (SMDH) demonstrate its role in driving adoption of new IDTs by manufacturers. The SMDH, led by Ulster University, aimed to support SME manufacturers to become more competitive by exploiting data more effectively. As part of its activity, SMDH funded a number of Lighthouse Projects, which provided grant funding for technology providers to engage with manufacturing SMEs and install IIoT technologies, to increase the amount of data collected by businesses. The adoption of IDTs by firms involved in two of these Lighthouse projects is explained below.

Mallaghan is a leading manufacturer of ground support equipment for the aviation industry. The firm saw significant potential to improve efficiencies, reduce costs, and become more environmentally sustainable through the use of IDTs. However, there had been some challenges in securing the significant capital expenditure required. Mallaghan therefore applied to the Digital Innovation Fund to de-risk this investment.

The key project activities related to installing sensors and software to improve data collection and interpretation throughout the manufacturing process. The project involved investment in a new digital system for the storage of component and product movement tracing data; installation of sensors to gather energy usage data; and installation of new sensors and software to provide data on the costs of lasers for metal cutting versus other techniques.

The project activities provided insights into production costs and processes, particularly on electricity and gas usage and the time required for certain processes. There have also been benefits for the wider manufacturing sector. The firm has worked with MEGA, an industry-led local network, to promote the project. Mallaghan is working closely with its supply chain to encourage adoption of IDTs, seeking to integrate suppliers into its digital system for data collection and storage.

A second Lighthouse Project provided funding to allow Devtank, a technology provider, to supply its OpenSmartMonitor solution at a discounted rate to businesses. SMDH Business Development Officers promoted the OpenSmartMonitor technology to SMEs across the country and referred those likely to benefit to Devtank.

Supplying the technology to multiple businesses allowed Devtank to develop its product from a prototype to a product ready to be implemented at scale. Devtank also learned more about the capacity and capabilities it needs in order to manufacture a product at scale, significantly increasing the potential scalability of OpenSmartMonitor, and resulting in a low-cost solution, accessible to a range of manufacturing SMEs.

ST06: Number of IDT providers selling to manufacturers for first time

6.16 As part of the ecosystem for generating wider adoption, it is encouraging to see that **MSI supported IDT providers to engage with and start selling solutions to manufacturers for the first-time**. Programme monitoring data recorded 15 spin-outs or start-ups created through MSI activities. This was matched by two beneficiary survey respondents reporting that their MSI-funded project had led to a spin-out or start-up company and another five respondents reporting an expectation of a new company in future.

6.17 **Stakeholders reflected on the importance of collaboration, funded by MSI, in creating market opportunities for IDT providers**. MSI's role in funding projects and initiatives that enabled SMEs to develop relationships with larger organisations and establish dialogue with partners was seen to be important in helping to ensure technology developments align directly with industry needs. The Accelerator programmes were seen as a particular useful approach to connecting leading UK manufacturers with pioneering technology startups to develop innovative solutions to industry challenges. In one case, Machine Intelligence (MI) partnered with BAE Systems to develop an AI solution for visual inspection for part of their quality assurance processes. The Made Smarter Technology Accelerator was seen to be crucial in making the collaboration happen. As a result of the project, MI is continuing to work with BAE Systems' FalconWorks division to explore additional applications for its AI systems, as well as working with other UK manufacturers to address the challenges they experience in visual inspection.

Achievement on investment outcomes

STO3: Increased investment in IDTs; ST08: Follow-on investment in IDT solutions produced by the programme

6.18 **MSI has generated private investment in IDTs, both in terms of match-funding and follow-on investment**. Programme monitoring data shows £100m was invested by industry in MSI projects and a further £102m was invested in follow-on or related activities. This gives a total of £202m, which exceeds the private investment target of £162m (i.e. £40m more or 25% above target).

6.19 Forty percent (10/25) of beneficiary survey respondents stated additional financial investment in their project as a result of MSI. The scale of this investment varied, from £2,500 to £400,000, and amounted to £1.1m across the ten organisations that reported additional investment. In one instance, this involved foreign direct investment, and a couple of respondents had also invested additional public funding into the project.

6.20 Case study evidence provides other insights into how MSI has stimulated follow-on investment in IDT solutions. A few external consultees were also aware of follow-on investment resulting from MSI, not only directly in the IDTs developed, but also in other related IDTs now being considered as a result of collaboration enabled by MSI.

Case study – follow-on investment in IDTs

PRIME-3D was a CR&D project between Q5D Technologies (IDT developer), the Manufacturing Technology Centre (MTC) and AWAN (a Taiwanese Technology company) to develop the technology for the application of circuit boards onto 3D surfaces composed of a standard substrate. Through the project, 3D circuit technology progressed from TRL3 (Experimental proof of concept) to TRL4-5 (Technology validated in a lab), whilst the machine they had developed was TRL5-6 (Technology validated in relevant environment). Since the project, Lockheed Martin lead on a further investment of $3m in Q5D Technologies, in part as a result of this technology.

The Self-Driving Tableting DataFactory – part of the Digital Medicines Manufacturing (DM2) Research Centre at CMAC (University of Strathclyde) – was designed to accelerate the development of pharmaceutical products through the use of IDTs. The project has resulted in a series of follow-on investment, including:

- *A PhD to undertake further research into the Tableting DataFactory, specifically focused on dissolution (not previously explored in the project).*
- *Since investing in the first robotic arm, CMAC has invested in an additional 11 robotic arms.*
- *Whilst not directly attributable to this project, CMAC has secured additional research funding which will be used to advance some aspects of the Tableting DataFactory (as part of the MediForge Hub).*

MI and BAE Systems partnered as part of the MSI Technology Accelerator. The challenge focused on transitioning BAE's visual inspection processes from film-based to digital X-rays, and the development of an AI solution to assist human inspectors in interpreting the X-rays. Through the project, MI's technology has gone from being a proof of concept (TRL 3) to a prototype system (TRL 6) which is now being used by BAE Systems in their weld inspection processes. Since the end of the project in 2022, MI has continued to work with BAE Systems on further projects seeking to drive the use of AI systems for visual inspection, building on the prototype developed during the MSI project. BAE Systems is also continuing to invest in AI solutions within its manufacturing processes, by both building its own internal data science capabilities and continuing to work with SMEs.

Achievement on skills outcomes

ST09: Increased skills in the use, development and application of IDTs

6.21 **MSI has contributed towards increased skills in the use, development and application of IDTs.** Three-quarters (33/43) of respondents to the beneficiary survey indicated that individuals within their organisation had acquired new skills due to the project, amounting to a total of 943 people. The number of upskilled employees varied among respondents, largely depending on their total workforce size, with three respondents indicating that more than 50 employees benefited from personal development through their involvement in projects. Twenty-five beneficiary survey respondents also reported an increase in R&D capabilities in a manufacturing context as a result of participation in MSI.

6.22 Monitoring data echoed these findings, with nearly 7,000 people recorded as receiving formal or on-the-job training related to MSI-funded projects. A large proportion (64%) of these people were upskilled via Innovation Hub projects.

6.23 Case study evidence illustrates how MSI activity has led to upskilling of staff within manufacturing. Through Platform One, the DM² Research Centre has supported increased understanding around the integration and standardisation of data and the effective deployment of IDTs, including the skills required to do this. Furthermore, as part of its Platform Five activity, DM² has developed a series of XR applications to enhance training and virtual collaboration between researchers and students within the CMAC laboratories, and has launched training via the SkillsFactory to the benefit of industry partners. Separately, the collaboration between BAE Systems and Machine Intelligence to develop a AI solution for visual inspection, to be used by BAE Systems' radiographers as part of their quality assurance processes, involved the radiographers providing feedback on the AI system's usability and sharing their expertise regarding the inspection process, which informed its development. This collaborative relationship not only improved the quality of the solution but also helped radiographers understand the system's value in enhancing their work, and increased their openness to use of AI solutions in future.

6.24 External consultees acknowledged MSI's role as a 'gateway' to more innovation through facilitating connections between partners and providing funding for initial collaborations. However, stakeholders recognised that high levels of collaboration are likely to require continued support and expressed a view that that significant skills challenges remain in relation to IDT adoption.

"If you were to survey the biggest manufacturers, their number one challenge would be skills – how do you have the skills to adopt technologies? MSI has done some work on that, but they could do a lot more. […] They need to work with the DfE to have programmes which mean we can address these skills challenges, and that there is strong alignment between the skills being taught and the needs of industry."

External consultee

ST11: Knowledge transfer/collaboration benefits

6.25 MSI's role in delivering knowledge transfer and collaboration benefits is evidenced through:

- 23 beneficiary survey respondents reporting working with new partners. These newly formed collaborations were mostly involved manufacturers and digital technology developers, but also included technology intermediaries and universities/RTOs.
- three quarters (32/43) of beneficiary survey respondents indicating that their involvement in MSI has increased their interest and willingness to engage in collaborative research partnerships in future.
- monitoring data recording 188 events organised by MSI Network, InterAct and the Research Centre from across industry, academia, and the public sector.

6.26 Facilitating collaboration was a key part of the rationale for the MSI programme: 9 out of 23 project lead respondents to the beneficiary survey indicated that difficulties in finding suitable collaborators was a key reason why they had not progressed the project prior to MSI funding. Evidence on delivery of collaboration benefits underscores how the programme has helped to address market failures in relation to coordination and networks.

ST12: Stronger academic capability & capacity in IDTs

6.27 **MSI has contributed towards stronger academic capability and capacity directly relating to IDTs.** A few external consultees viewed the opportunity for universities to engage with industry via MSI as supporting the translation of research into industrial settings by ensuring research is relevant to industry needs and providing feedback to academia as to potential future lines of research.

6.28 Increased academic capability was driven by Research Centres - each of which is led by a UK university. Monitoring data suggest that Research Centres engaged with an additional 76 academics (outside the Research Centre consortia). InterAct also reported working with 40 universities. The volume of publications produced across the Challenge is also indicative of increased academic capability: 430 papers have been published, of which 204 were published by the Research Centres, 114 as part of a CR&D project, 97 by the Innovation Hubs and 15 by InterAct. Beneficiary survey respondents reported that four projects had resulted in academic publications and anticipated that seven publications were expected in future as a result of MSI funded projects.

6.29 One example of the strengthening of academic IDT capability is the Collaborative Human Robot Crop Collection project, led by academics at the Smart Cobotics Research Centre at the University of Strathclyde in collaboration with researchers from six other UK universities. The research explored Human-Robot collaboration in the collection of grapes in a vineyard, and resulted in the production of four academic papers. As a result of the research, the team secured a follow-on project working with a group of Scottish Tea farms to trial the use of a robot to test the soil quality, and to remove loose leaves on the ground. Outside of farming, but using the same principles, the team were shortlisted for a Knowledge Transfer Partnership (KTP) with Bosch and WB Alloys, that will use some of the same principles identified through the research.

Long-term outcomes

6.30 Beyond the Challenge lifespan, the programme is expected to contribute towards a series of longer-term outcomes, primarily relating to improved business performance and environmental sustainability but also including continued development of the IDT ecosystem. While significant progress on these outcomes is not anticipated by this point, **there is evaluation evidence that indicates early improvements on jobs and sustainability outcomes** (see also section 8 for econometric evidence on outcomes).

Table 6-1: Achievement on long-term outcome metrics

Target (by 2034)	Achievement
£2.3bn added to Manufacturing sector GVA	See section 8
4,000 IDT skilled jobs created	459 jobs
Up to 30% productivity improvement in impacted IDT services and organisations	10% increase in productivity (range from 0%-65%)
Up to 4.5% decrease in carbon emissions in impacted IDT services and organisations	15% reduction in $C0_2e$
Up to 25% decrease in waste in impacted IDT services and organisations	11% reduction in waste

Source: SQW based on information from the Made Smarter Innovation Challenge. Productivity, carbon emissions and waste reductions given as median average of the 48 CR&D projects reporting impact.

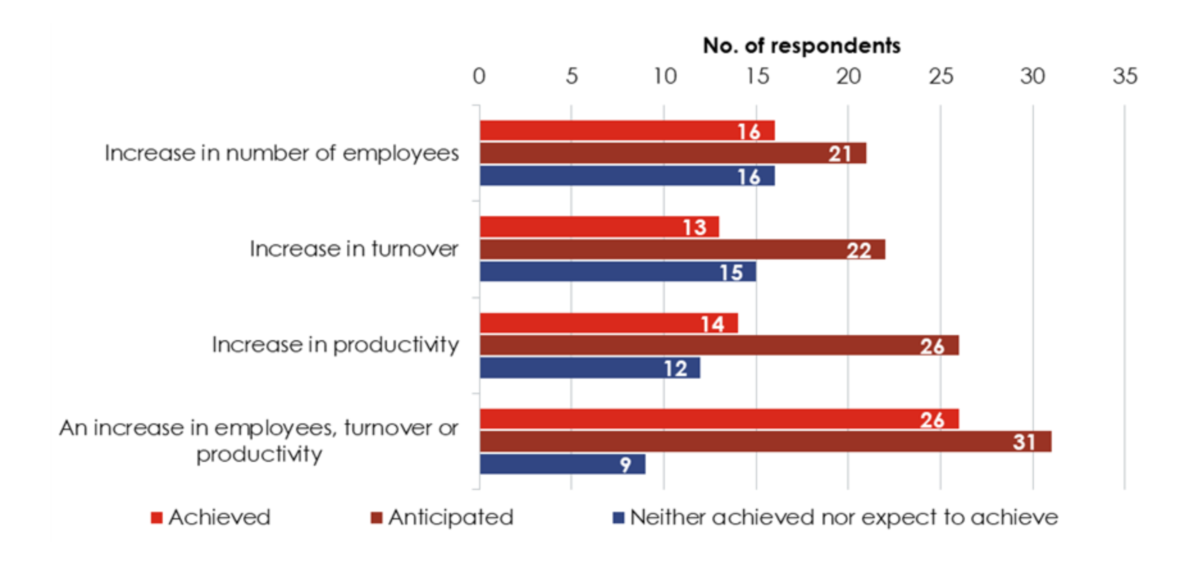
Business outcomes

LT01: Net change/ increase in: Productivity, GVA, Employment

6.31 Most (34/43) beneficiary survey respondents[50] have achieved (or expect to achieve) an increase in jobs, turnover or productivity, as a result of MSI-funded projects. More than half (26/43) have already achieved one or more of these. Around three quarters of manufacturers (13/17) reported realised/anticipated improvements in productivity, and a similar proportion of technology developers (8/11) reported realised/anticipated increases in turnover.

[50] Including manufacturers and digital technology firms.

Figure 6-4: Business performance outcomes resulting from MSI-funded project (n=43)



Source: SQW analysis of beneficiary survey data.
Note: total exceeds 43 as some organisations have both achieved benefits, and anticipate achieving further benefits in future.

6.32 The extent to which respondents had experienced or anticipated experiencing these benefits varied. In aggregate, respondents reported that MSI-funded projects had already resulted in an additional 28 employees to date, and an additional 68 employees were expected in the next three years. Of the 11 digital technology developers responding to the survey, six reported that they had increased in employee numbers because of involvement with MSI, four of which anticipate continued employment growth in the next three years. One IDT provider had not yet increased their number of employees, but expected to shortly. This is backed by case study evidence, whereby three IDT start-ups (Singular Intelligence, Devtank and Plus X Innovation) had already employed or anticipate employing additional members of staff to support the scaling up of their businesses, and programme monitoring data that indicates 459 jobs have been created already by the programme.[51]

6.33 **Over 80% beneficiary survey respondents reported achieved or expected increases in turnover**, with five respondents anticipating that outcomes from their project will result in more than £1m in additional turnover (Table 6-2). Effects on turnover are also illustrated through case study evidence, for example by Devtank, which is seeking to increase turnover through partnering with international resellers to provide their OpenSmartMonitor solution across both Europe and Asia. Monitoring data show that the achieved sales of new IDT solutions brought about through MSI is nearly £7m, of which £4.26m is export sales.

[51] Note this is self-reported data and is a gross figure. It was not possible for SQW to verify the validity of these jobs data.

Table 6-2: Scale of outcomes resulting from MSI-funded projects (n=43)

Outcome	Number of businesses reporting they have achieved	Scale of achieved benefit	Number of businesses reporting anticipated achievement	Scale of anticipated benefit
Increased no. of employees	16	28	21	68
Increased turnover	13	• £5k-9k: 1 respondent • £10k-£99k: 4 • £100k-£499k: 4 • Don't know: 4	22	• £10k-£99k: 1 respondent • £100k-£499k: 6 • £500k-£999k: 5 • £1m-£10m: 5 • Don't know: 5
Increased productivity	14	N/A	26	N/A

Source: SQW analysis of beneficiary survey data.

6.34 MSI has contributed to improved productivity amongst beneficiaries. The survey findings show that about a third (14/43) of respondents had already improved productivity, and 60% (26/43) anticipated productivity benefits within the next three years. Programme monitoring data recorded productivity improvement across the Challenge as 10%. While it is difficult to assess the combined productivity impact of MSI across all beneficiaries, case study examples demonstrate how MSI has resulted in productivity gains.

Case study – productivity improvements

Two case studies demonstrate how MSI has already contributed towards productivity improvements, and identification of further productivity improvements in future.

As part of the MMS Research Centre, the University of Swansea worked with the Tata Steel plant in Port Talbot to explore the use of machine learning to improve existing simulation modelling. Tata Steel has a simulation process control model that is used to simulate the inputs in the plant (e.g. temperatures, speeds, water flows) to predict the temperature transformation required before steel slab coiling. Achieving the correct temperature is crucial in achieving the desired mechanical properties of the finished steel strip and avoiding rejections or re-working strips.

The main output from the project was an algorithm that has helped Tata Steel to identify the optimum parameters for their simulation model, allowing them to more accurately predict cooling and final coiling temperatures. By using the machine learning algorithm, *the time taken to determine optimised parameters for the process model has reduced from six months to a week per product type. Some product types are already being produced using the optimised parameters from the algorithm, meaning Tata Steel has already seen a reduction in reworks of 90%. Tata Steel intends to use the model to support the optimisation of every product type produced, and there is scope to develop the approach to more accurately reflect each product type. Moreover, there is potential to apply a similar approach to other models elsewhere in the business, such as process control models.*

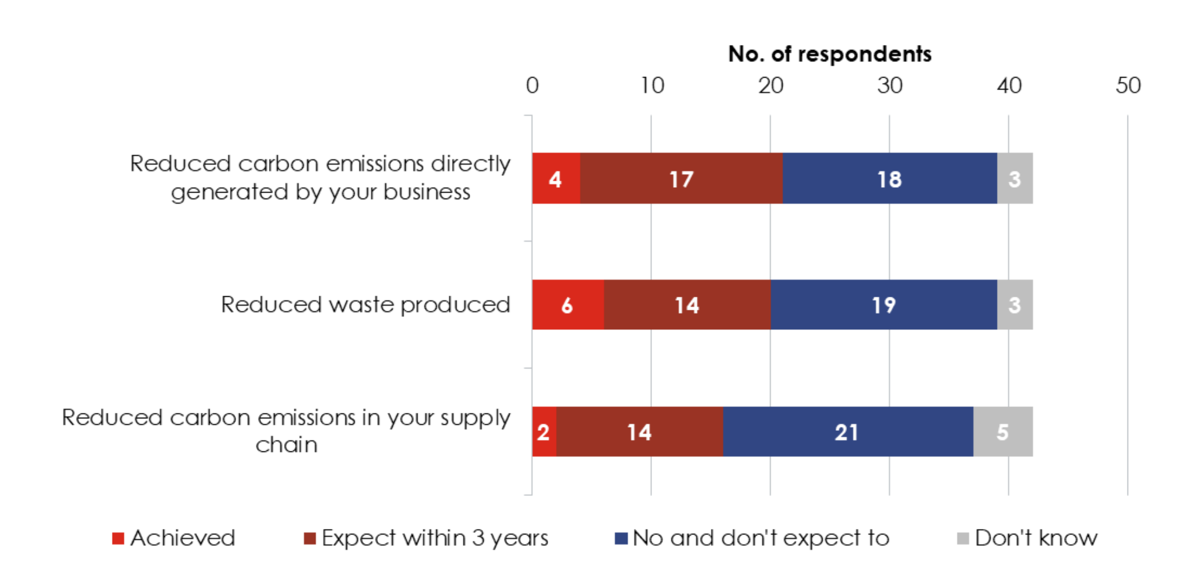
CAMPFIRE (Certified AM Parts Finished with Intelligent Robotics Engine) was a £535k CR&D project aiming to advance the role of robotics in Additive Manufacturing (AM) processes at the post-processing manufacturing phase. The project was led by Rivelin Robotics, and supported by three partners who provided use cases in different sectors: GKN Aerospace (aerospace), Attenborough Dental (medical) and Material Solutions (energy). The aim of the CAMPFIRE project was to take an existing robotic microfactory prototype – designed to automate the removal of AM support structures - and bring it to a production standard by demonstrating the utility of this prototype in three sectors.

Through the project, the technology progressed from a prototype to production standard, moving from TRL6 to TRL8. The potential productivity benefits to the UK manufacturing community of adopting this technology are significant. First, by using a robot instead of a human, this post-processing can occur at anti-social hours (increasing productivity by up to 50%) and allow businesses to assign their staff to more skilled roles. By using robots, accidental errors - where a piece is incorrectly post-processed, resulting in wasted materials and a slowdown in the production - are far less likely. The SME partner estimated that adopting this technology might save between £100k - £150k a year

Sustainability outcomes

6.35 **There is early evidence indicating improvements on sustainability outcomes**. Beneficiary survey respondents identified sustainability outcomes derived from their MSI-funded project: reduced direct carbon emissions and reduced waste were both reported by nearly half of respondents, although the majority of these were expected rather than achieved outcomes. Around one third (14/43) of respondents thought that their project will also lead to reduced carbon emissions throughout their supply chain (Figure 6-5).

Figure 6-5: Sustainability outcomes resulting from MSI-funded project (n=43)



Source: SQW analysis of beneficiary survey data.

6.36 Case study evidence provide examples of how IDTs have begun to improve efficiency and reduced waste, and how these benefits are expected to grow as manufacturers apply new IDTs to other processes. Batch.Works (a small circular manufacturing company) collaborated with Plus X Innovation (a workspace and innovation support provider) and Matta Labs (an AI research spin-out from the University of Cambridge) on a CR&D project to develop multiple technologies, culminating in an automated 3D printing facility that uses robotic control and AI to scale for local batch production. Through the integration of the technologies, Batch.Works' failed print rates dropped from 10% to 1%. Additionally, the introduction of automated print removal reduced idle heating, saving up to 90% of energy per print cycle compared to continuous heating, and AI-powered failure detection cut waste material from failed prints by 80%. Over the next three years, life cycle assessment estimates suggest that 1,685 tonnes of CO_2e will be avoided, and by 2029, projected material savings are expected to reach 1,380 tonnes.

6.37 Monitoring data support these findings. Across the board, programme monitoring data report an 11% decrease in waste. In addition, the SMDH reported a 22% potential decrease in energy consumption, amounting to 656,744 kWh, for the six companies which implemented the SMDH Energy Insights Product. This decrease in energy consumption translates to a potential reduction in CO_2 emissions of 162 tonnes (a 30% reduction).

Progress against programme logic model

6.38 **The Challenge delivered against all of the short-term outcomes identified within the logic model**, including raising awareness of IDT uses and benefits, supporting innovation progress and adoption (among programme participants), stimulating follow-on funding, and increasing IDT related skills. **There is also evidence of early achievement on longer-term outcomes such as jobs, productivity, and reduced waste and CO_2e.**

6.39 Evidence from a range of sources including the beneficiary survey, consultations with those involved in the Challenge, and case studies, suggests that **the two key mechanisms that helped translate outputs into outcomes within the programme lifespan were:**

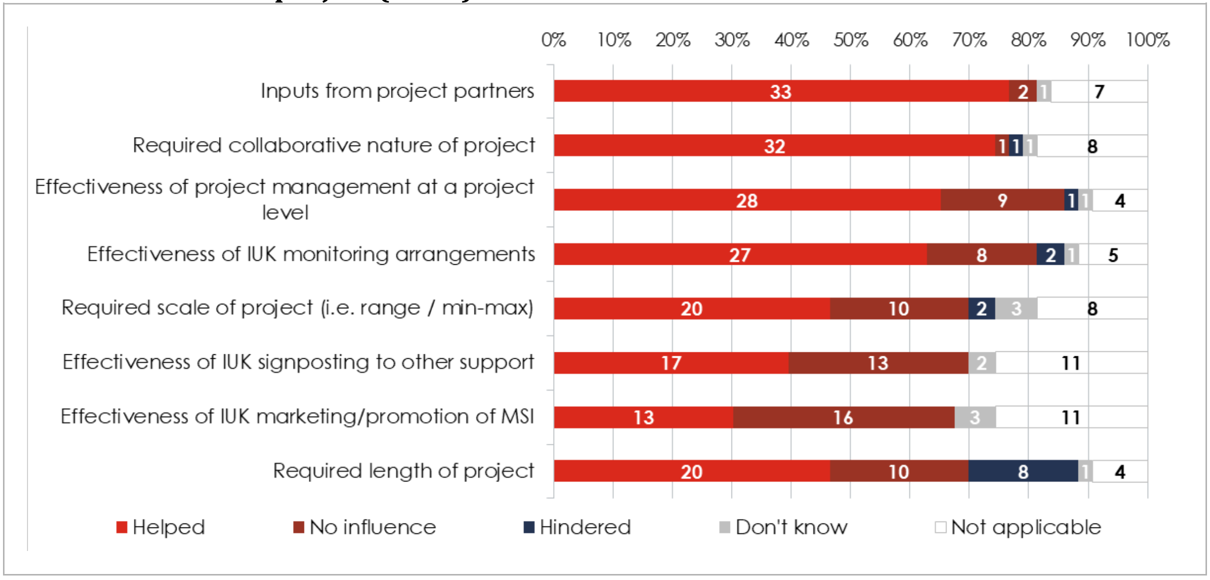
- grant funding to de-risk and lever investment into innovation
- collaboration to stimulate more innovative and relevant technologies.

6.40 There are more diverse views on the role of the package of Challenge interventions as a mechanism of change as outlined below.

6.41 Grant funding for projects has been important in achieving outcomes and impacts both in terms of funding directly to industry (e.g. CR&D projects, Technology Accelerator) or to academia to conduct activities that support industry (e.g. Research Centres, Innovation Hubs). The funding directly tackled the biggest barrier to innovation as identified by survey respondents: the majority of project leads (15 out of 23) reported that their projects had previously been prevented due to difficulties in securing finance. MSI funding has also been used to address the barrier of lack of access to necessary facilities, as reported by five respondents, whereby funding has been used for capital spending or to fund research using specialist facilities.

6.42 Survey evidence was also strong regarding the role of collaboration in contributing towards outcomes and impacts. Lack of appropriate collaborators was reported as a key barrier prior to MSI, reported by nine project leads. This was particularly the case for digital technology developers. Nearly all beneficiary survey respondents (33/36) indicated that inputs from project partners had helped the realisation of project benefits and that collaboration was important to the outcomes generated (32/36) (Figure 6-6).

Figure 6-6: Aspects of MSI that have helped/hindered/had no influence in the realisation of benefits from the project (N=43)



Source: SQW analysis of beneficiary survey data

6.43 There was mixed feedback on the importance of MSI as a package of interventions supporting change. Stakeholders pointed to examples of organisations that had benefitted from support from more than one workstream, such as Riscon Solutions and Total Control Pro, both of which participated in the Made Smarter Technology Accelerator, subsequently applied for CR&D funding and have worked with both the Smart Manufacturing Data Hub and the Digital Supply Chain Hub. Authentise, a manufacturing software company exhibited at Made Smarter Innovation Alley, then had funding for a CR&D feasibility study and partnered on another CR&D project. Some of the larger companies, such as BAE Systems, also had multiple forms of involvement with the Challenge.

6.44 Where these various engagements have occurred, the participants and wider stakeholders view them positively. It is likely that a company has pursued additional involvement with the Challenge precisely where they have appreciated the benefits of the engagement and subsequent opportunities fit with company needs. The reverse is also likely to be true although such evidence is not as forthcoming from consultees.

6.45 An observation from several stakeholders is that progression from low TRL research through to commercialisation and adoption may take a number of years, even longer than the five years of the MSI Challenge. Thus a set of workstreams woven into a single programme can only be effective at scale if it has the longevity to support multiple companies through the innovation process. This was possible for some of the companies who engaged with the Challenge in its first couple of years but later entrants have not had time to take advantage of multiple strands of support.

6.46 In summary, the programme approach to providing funding and encouraging collaboration across firms, and between industry and academia, has been broadly successful in yielding projects that generate the desired outputs and these are translating into the desired outcomes.

6.47 At this stage, therefore, there are indications that the next stage of the logic model are likely to be reached (i.e. longer term outcomes expected after 2026/27). Some small-scale outcomes relating to sector performance and sustainability benefits have already been realised by project partners, and are expected to continue in future. However, the extent to which long-term outcomes are realised will ultimately be influenced by other factors affecting the future performance of the UK manufacturing sector, including whether new technology solutions are sufficiently attractive to the market and whether they are sufficiently effective to make a real difference to adopting firms (in terms of productivity, waste, CO_2e emissions etc.), the level of digital maturity in the manufacturing sector, particularly among SMEs, and the effectiveness of other interventions to support IDT adoption.

7. Additionality and contribution

Summary

- Overall, the MSI Challenge is associated with **medium-to-high additionality**. This applies to both the Challenge activities and outcomes reported by beneficiaries (of CR&D and Innovation Hub funded projects) and stakeholder feedback. This is a positive finding given the wider context in which MSI has been delivered.
- The beneficiary survey found 9% reporting full outcome additionality and a further 91% indicating partial outcome additionality i.e. the Challenge helped to increase the speed, scale and quality of outcomes. These beneficiary survey results are supported by the findings from the case studies and feedback from unsuccessful applicants, for whom not receiving funding was thought to have negatively affected their growth.
- Relatedly, MSI played a crucial role in realising benefits: around a fifth (9/42) beneficiary survey respondents believed that MSI was the critical factor in achieving their outcomes and almost a half (20/42) identified MSI as an important contributory factor.
- The factors related to MSI that had the positive influence were collaboration and inputs from project partners. The most useful factors outside of MSI were availability of information about new technologies, other ongoing innovation activity and pre-existing assets including relationships and networks.
- The factors that most negatively influenced project delivery included geopolitical and socio-economic issues (included the UK's exit from the EU, the Covid-19 pandemic and issues associated with the war in Ukraine).
- The ability of the MSI Challenge to deliver longer-term outcomes and impacts will be significantly influenced by market conditions and policy context, which will determine the extent to which organisations continue to innovation activity and whether others adopt IDTs.

7.1 This section sets out the extent to which the activities and outcomes of the MSI Challenge have been additional i.e. the extent to which benefits would have occurred without MSI. This analysis is based on evidence from the beneficiary and unsuccessful applicant surveys (covering CR&D and Innovation Hub funded projects), case studies, and stakeholders interviewed.

Additionality

Activity additionality

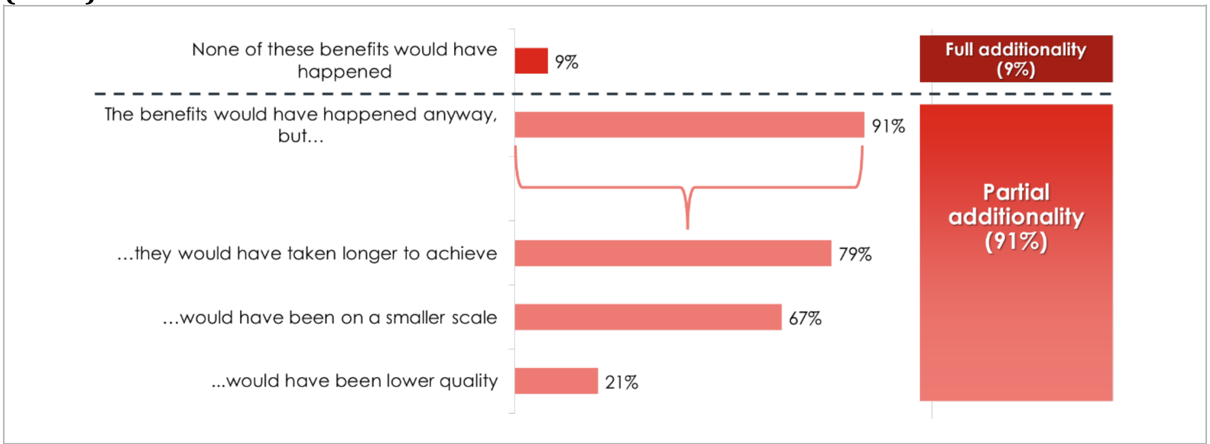
7.2 **Responses to the beneficiary survey suggest that most projects (53%) likely would not have gone ahead without MSI funding**. A quarter of respondents (10/42) said that their project would definitely not have been taken forward without MSI funding and a slightly higher proportion (12/42) said it probably would not have been taken forward. For those that would have continued the project anyway, MSI funding was felt to be important to enhanced delivery and outcomes: beneficiaries reported that MSI funding allowed projects to be delivered more quickly (18/22), on a larger scale (17) and to a higher quality (13). Thus all beneficiary survey respondents (of those able to comment) indicated that MSI provided some degree of activity additionality to their project.

7.3 These findings are corroborated in the unsuccessful applicant survey. Half (13/26) of respondents had been able to progress their projects without MSI funding (largely through self-funding, 10 respondents) but these projects were delivered on a smaller scale (eight) or later (six) because of a lack of MSI funding.

Outcome additionality

7.4 **Most beneficiary survey respondents (22/24) reported partial additionality**, i.e. the outcomes realised would not have occurred to the same extent without programme support (Figure 7-1). The Challenge was primarily seen as helping projects to achieve outcomes more quickly (19/24) or on a larger scale (16/24). A few (5/24) also believed that the benefits would have been of a lower quality.[52] There was no full deadweight[53] reported by beneficiaries.

Figure 7-1: Without this support from MSI, which of the following would have happened? (n=24)

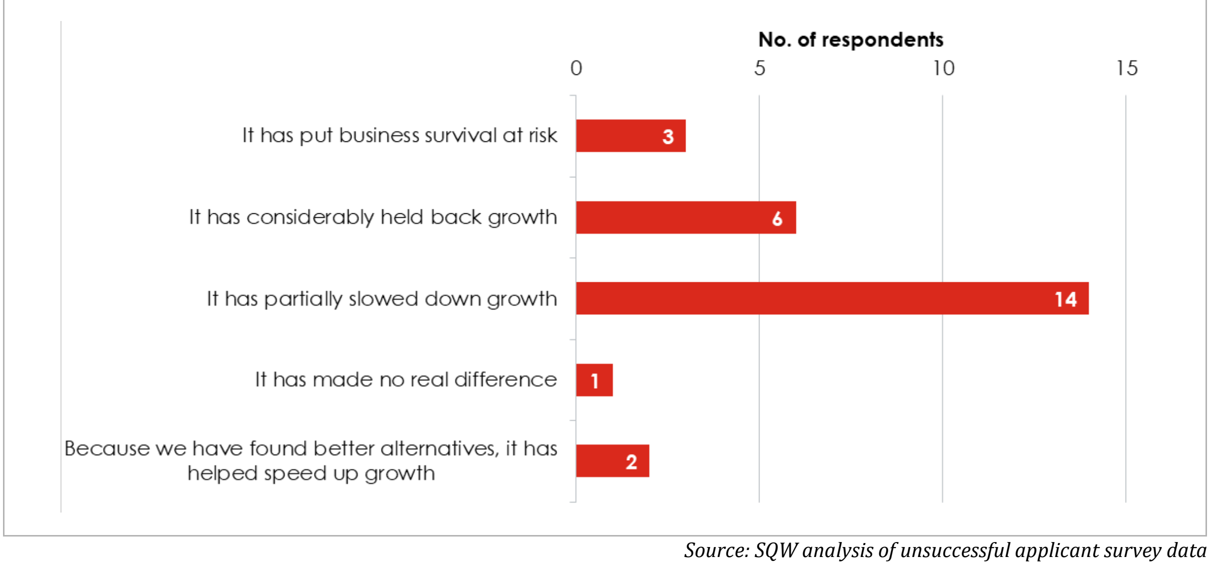


Source: SQW analysis of beneficiary survey data. Note, the bottom three bars represent percentages of the total number of respondents (not of the 91% reporting partial additionality)

[52] For example, beneficiaries would not have been able to engage with specialist resource and that the project would not have had the same profile without funding.
[53] Deadweight refers to impacts that would still have occurred if public support had not been provided.

7.5 Unsuccessful applicant survey respondents were asked about how their business had been affected as a result of not securing MSI funding to gain another perspective on the programme additionality. For most, it was thought to have partially slowed down (54%, 14/26) or considerably held back growth (25%, 6/24) for the company. This reinforces the additionality of MSI, as more than three quarters of those unsuccessful in their application to MSI (CR&D or the Innovation Hub funded competitions) experienced worse outcomes than they would have expected had they been successful.

Figure 7-2: Effect of not receiving MSI funding on business' development (n=26)



Source: SQW analysis of unsuccessful applicant survey data

Evidence from consultations and case studies

7.6 All of the 15 case studies also indicated some degree of additionality for the MSI Challenge. Eight reported full additionality, that is that the outcomes realised would not have been possible without the MSI programme. These spanned MSI's work strands, including CR&D projects, Research Centres, Technology Accelerators and InterAct. In some instances, outcomes would not have been possible due to the lack of alternative funding available from elsewhere, meaning that only a programme like MSI would have enabled activity to go ahead. In other instances, the outcomes were realised because of MSI's role in coordinating innovation activity, both in helping to build new connections between digital technology developers and manufacturers, and in the provision of project management resource to enable successful project delivery. Without MSI as a convenor, it is unlikely that these connections would have been made, and barriers to finding suitable partners would not have been surmounted.

"Probably none of these benefits would have happened. We definitely would have struggled, because access to the real-world use cases is difficult, and access to the end users does make a big difference in terms of developing technology which does actually deliver benefits, rather than imagining use cases and the hypothetical benefits it can bring. The programme provided funding for staff time and resource, and allowed consortia to come together, which wouldn't have been possible otherwise."

Programme beneficiary

7.7 This sentiment was echoed by external consultees. Half of them (six out of twelve) thought that none of the outcomes achieved would have been possible without the programme. While the significant scale of funding was acknowledged as an important factor to achieving outcomes, the facilitation of activities and collaboration was viewed as equally important. Consultees noted how MSI created opportunities for digital technology SMEs to collaborate with UK manufacturers, both small and large, to develop solutions and enhance their processes. Without the MSI programme, these introductions were perceived to have been highly unlikely, as there would have been no platform for technology providers and manufacturers to connect and demonstrate the value of collaboration. The follow-on work resulting from MSI activities illustrates the added value of the programme, where introductions have led to initial outcomes and then sustained collaboration.

7.8 For those case studies that may have otherwise progressed, all felt that MSI had contributed towards outcomes either being realised more quickly, to a larger scale, or to a higher quality. The key mechanisms through which the Challenge had supported enhanced project outcomes were:

- *Outcomes were achieved more quickly* because MSI funding ensured industry partners had the resources to dedicate to innovation, and MSI project management resource helped the projects to maintain progress. In some instances, MSI support (e.g. via the Innovation Hubs) acted as a catalyst to project delivery by providing expertise and bringing together the right project partners quickly via existing networks.

- *Outcomes were on a larger scale* because funding used to de-risk investment helped organisations, particularly SMEs and academic institutions, to test and engage in more exploratory research. Without MSI, these projects likely would have been narrower in scope and delivered at a smaller scale, given financial constraints and the challenges associated with quantifying short-term benefits of exploratory research. For example, the scale of funding provided to the Research Centres allowed for an integrated approach to IDT research. The variety of different activities funded by MSI were seen to be important to delivering outcomes at scale, whereby some beneficiaries have been involved in interconnected projects across different workstreams, and therefore been able to apply transferable knowledge between projects.

- *Outcomes were of a higher quality,* largely as a result of the cross-sector collaboration funded by MSI. This enabled IDT projects to gather perspectives from a diverse set of stakeholders, and therefore resulted in innovation relevant across different manufacturing sectors. For small digital technology developers, collaborative projects funded by MSI have enabled them to gather user feedback on their technologies, and develop solutions better suited to the needs of the manufacturing sector.

7.9 **Not surprisingly, programme team members viewed MSI as having strong additionality**. The majority noted that the benefits achieved would not have been of the same quality without the MSI Challenge. Although individual projects might have proceeded due to the inherent need for businesses to innovate and stay competitive, the significant cultural shift towards collaboration, continuous improvement, and skill investment would not have occurred.

7.10 Two programme team members commented that this was partly due the breadth and diversity of support. For example, CR&D projects would have not benefitted from engagement with strands like the Innovation Hubs, or the Accelerators in other programmes; and therefore would have missed out on the diverse perspectives that they provide.

"The programme is fairly unique in terms of its breath and the different elements, which wouldn't have occurred without it. This said, IUK, EPSRC and ESRC would have funded things in this space without MSI. EPSRC was already funding things in the general manufacturing digital space. […] Innovate UK would have delivered CR&D projects through their general routes, but wouldn't have had the Hubs, Accelerator etc. It's the package of support which differentiates MSI from business-as-usual activity."

Programme team member

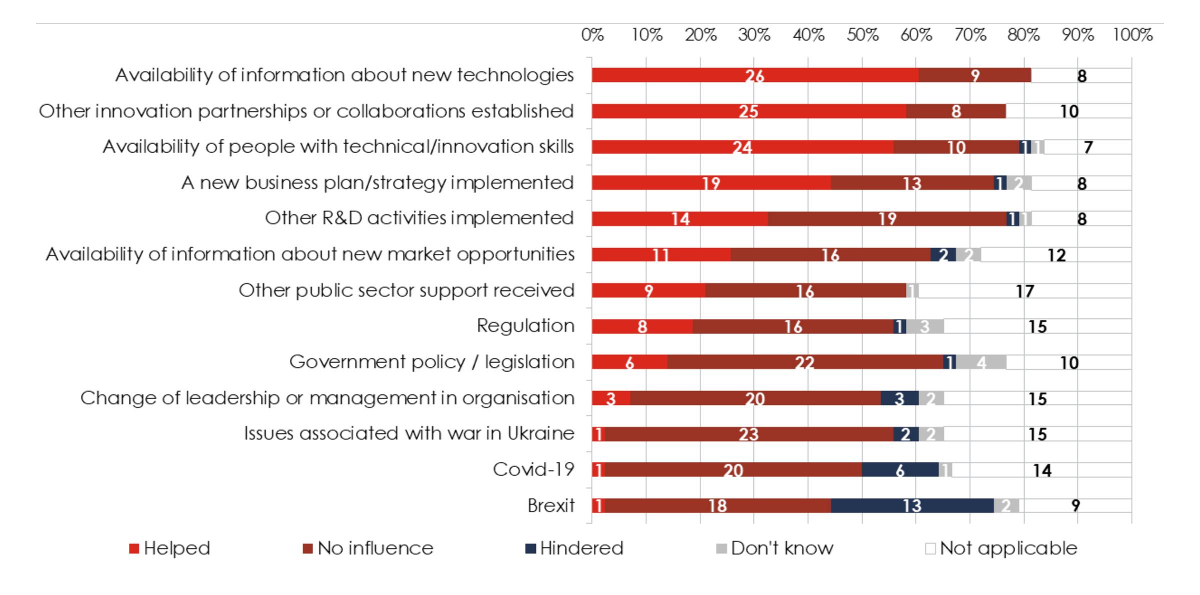
Contribution

7.11 More than two thirds of beneficiary survey respondents believed that MSI was either the <u>critical</u> (9/42) or an <u>important</u> contributory (20/42) factor in achieving outcomes. This sentiment was particularly strong among manufacturers, with three quarters of manufacturing respondents indicating MSI was a critical or important factor, compared to about half of digital technology developers.

7.12 Beneficiary survey respondents identified factors related to MSI and other factors that influenced project delivery, and in turn project outcomes. **The factors related to MSI that had the most positive influence on project delivery were inputs from project partners and the required collaborative nature of the projects**. Other elements of MSI's programme design considered to be helpful were monitoring requirements and the required scale and length of projects, although a small number of respondents reported that at times these had hindered project delivery. The required length of the project was considered to have hindered the project for eight respondents. Around half of respondents found MSI's signposting to other support and/or promotion of the programme useful.

7.13 The most useful factors outside of MSI that supported project delivery for beneficiary survey respondents were availability of information about new technologies, other ongoing collaborative innovation activity, and sufficient access to technical/innovation skills (Figure 7-3). These three factors were felt to have particularly aided project delivery for manufacturers. The factors that most negatively influenced project delivery included geopolitical and socio-economic issues (included the UK's exit from the EU, the Covid-19 pandemic and issues associated with the war in Ukraine) although these only affected a minority of projects.

Figure 7-3: Non-MSI factors influencing project delivery



Source: SQW analysis of beneficiary survey data

7.14 External stakeholder and case study consultees mostly viewed MSI as either making a critical or important contribution alongside other factors, in achieving the realised outcomes. The key aspects of MSI supporting the achievement of outcomes were seen to be:

- the facilitation of collaboration, which was thought not to have been possible without MSI and one of the key factors driving outcomes
- the bringing together of multiple sectors and encouragement of cross-sector working was seen to be unique, with no comparable opportunities
- the agenda-setting nature of MSI, with a small number of consultees observing that some businesses and organisations planned their activity directly in response to MSI funding calls. On this view, MSI is seen to be fundamental to the existence and nature of some projects.

7.15 Case study evidence indicates other factors that have contributed towards outcomes realised by MSI-funded projects, including pre-existing capital and infrastructure of project partners (funded through internal investment or other public funding), the use of industry networks and relationships to support project outputs, and the application of transferable learning from other complementary research activities (e.g. future manufacturing research hubs) to enhance project delivery and its outcomes.

7.16 Overall, the additionality and contribution of the Challenge towards outcomes is strong. In the longer-term, stakeholders considered that outcomes for the wider UK manufacturing industry will be influenced primarily by contextual factors such as barriers to adoption like low digital maturity among SMEs and a lack of incentives for businesses to innovate. A small number of stakeholders therefore raised questions about the potential for scalability of innovations and technologies generated through MSI projects beyond the programme participants. The role of

Made Smarter Adoption (MSA) in helping businesses overcome key barriers to innovation adoption was seen to be important.

8. Econometric analysis

Summary

- The results from the econometric analysis indicate that the **MSI Challenge has had positive statistically significant impact on the employment of beneficiary companies.**[54] On average, following MSI support, the employment of beneficiaries is c. **14%-15% higher** compared to two comparison groups.
  - **Group 1:** a group of unsupported companies from the wider business population
  - **Group 2:** unsuccessful applicants to the MSI Challenge.
- The employment results are statistically robust and informed our preliminary assessment of the value for money (set out in Section 9).
- At this stage, **no statistically significant impacts on turnover growth were found** between the beneficiaries and the matched comparison group (i.e. Group 1). However, on average, following MSI support, beneficiaries have c. 23% higher turnover than is predicted by the path of unsuccessful applicants.
- The results for employment and turnover reflect the often long pathways in the innovation and commercialisation process for companies: employment effects come first followed by measurable increases in turnover and productivity over time if projects are successful in the market.

8.1 This section presents the result of a quasi-experimental analysis of MSI's impacts on business growth (employment and turnover) of companies supported through the CR&D, SMDH Innovation Hub and DSCH Innovation Hub strands of MSI.

Beneficiaries

8.2 MSI beneficiaries were profiled on key characteristics, including their age, size, geographical location, economic sector, innovation activity and when they accessed the support. This descriptive analysis was predominantly based on the information from the Challenge monitoring data and the Beauhurst platform.

[54] These relate to 243 SMEs supported through the CR&D, SMDH Innovation Hub and DSCH Innovation Hub Open Call strands of MSI.

8.3 According to the monitoring data, MSI supported 243 SMEs and 71 large firms.[55] The econometric analysis focused on SMEs and not large companies as it was not possible to disentangle the impacts of MSI from other activities carried out by large companies.[56] Of the 243 SMEs in scope, 232 were successfully matched to the Business Structure Database (BSD) by the ONS Secure Research Service, equivalent to an approximate match rate of 95%.[57] Furthermore, all but two of the companies were identified on Beauhurst, i.e. there was almost full coverage of the beneficiary population for profiling and impact analysis.

8.4 The analysis was carried out at the programme level rather than by strand for a few reasons:

- SMEs could be (and were) supported through multiple strands – for analysis purposes, in such cases, their first engagement with the programme was considered to be the start of support.
- the CR&D strand dominated in terms of the number of supported companies, with the other two strands having insufficient numbers for a meaningful separate statistical analysis.

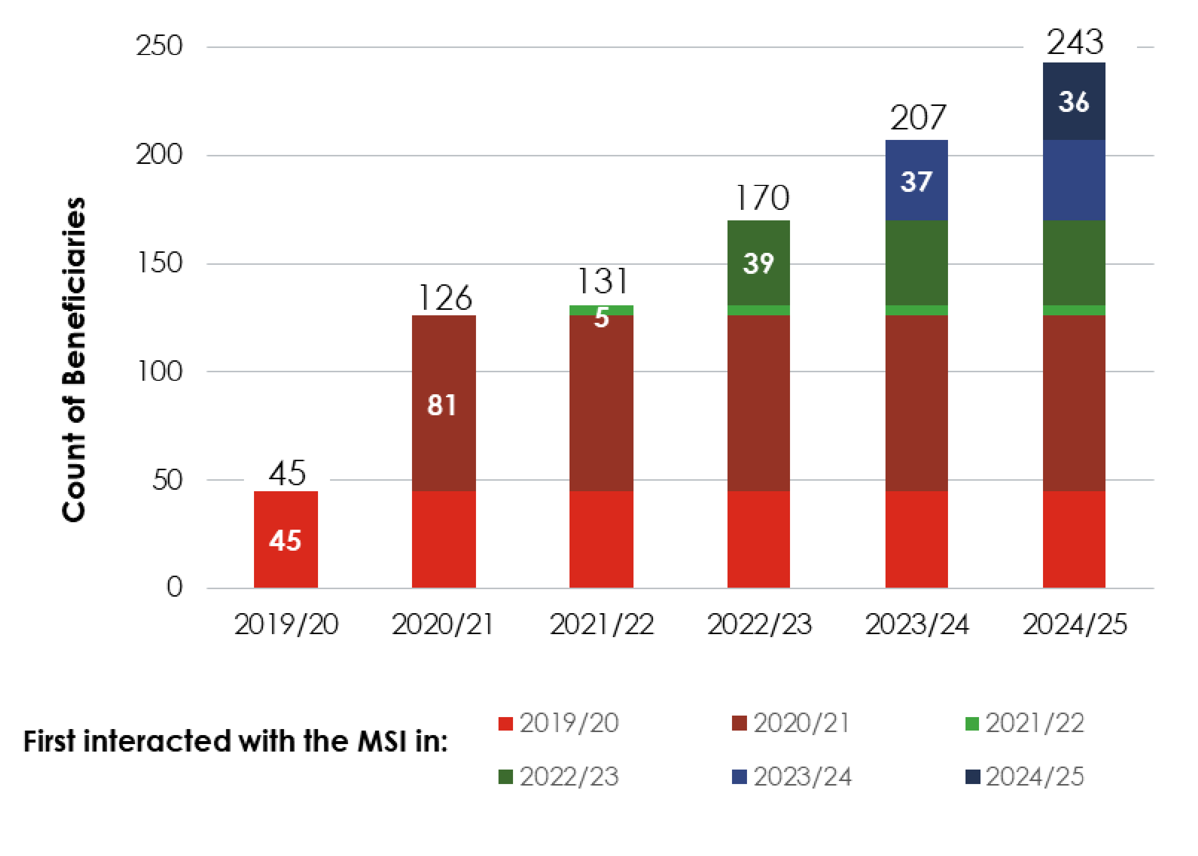
8.5 Approximately 74% (179) of the SMEs had their first engagement with the CR&D strand, c. 14% (33) with the SMDH Innovation Hub, and c. 13% (31) with the DSCH Innovation Hub.

Time profile of the support

8.6 As shown in Figure 8-1, the support was provided relatively evenly throughout the duration of the programme. On average, every year, 41 companies started their engagement with the programme. However, in 2020/21, 81 SMEs enrolled on the programme (nearly double the average), and in the following year only five SMEs were added to the pool (which is a reflection of the sequencing of programme activities).

[55] Among beneficiaries were also universities, but given that we are interested in firm-level outcomes, they are outside of the scope of the analysis.
[56] To confirm this conjecture we did create a separate comparison group for large beneficiaries and carried out the DiD analysis for them. We found no statistically significant differences between large MSI beneficiaries following their participation in the projects and the comparator companies. However, the lack of differences does not indicate the absence of impacts, it is possible that the results are affected by the smaller sample size making it harder to statistically distinguish the effects of interest from the results of other activities undertaken by those firms.
[57] Not all companies can be found in BSD due to failure to meet the criteria for inclusion (e.g. being registered for PAYE), or an incorrect or otherwise missing CRN.

Figure 8-1: Cumulative number of beneficiaries over time (financial years)



Source: SQW analysis of monitoring data

Sector and innovation focus

8.7 In line with the focus of MSI, the beneficiaries were found to be highly concentrated in three sectors of the economy. According to their primary SIC 2007 code, 81% of beneficiaries were in: manufacturing (section C); information and communication (section J); and Professional, scientific, and technical activities (section M). The first two sectors were substantially overrepresented among the beneficiaries relative to the UK's wider business population (see Table 8-1).

Table 8-1: Top sectors of MSI SME beneficiaries compared to UK SMEs

Sector Group	MSI SME Beneficiaries		UK SMEs (2023)
	Count	%	%
C - Manufacturing	81	33%	5%
J - Information and communication	80	33%	7%
M - Professional, scientific and technical activities	36	15%	13%

Sector Group	MSI SME Beneficiaries		UK SMEs (2023)
	Count	%	%
G - Wholesale and retail trade / repair of motor vehicles and motorcycles	8	3%	15%
N - Administrative and support service activities	8	3%	8%
S - Other service activities	7	3%	4%
F - Construction	6	3%	14%

Source: SQW analysis of Beauhurst and ONS data

8.8 In addition to SIC2007 codes, Beauhurst has its own indicator of business activity in modern and emerging sectors – 'buzzwords'. Approximately one third of beneficiaries were associated with at least one buzzword, which can be seen as an indication of their high innovation activity, since this classification tends to highlight newer sectors reliant on cutting edge technology.

8.9 The top five most common buzzwords among the beneficiaries are shown in Table 8-2 and align with the more general trends observed in the UK economy – the popularity of software solutions, growing capabilities and importance of artificial intelligence, the transition towards a greener economy, etc.

Table 8-2: Beauhurst buzzwords most common among beneficiaries

Buzzwords	Number of beneficiaries
Software-as-a-Service (SaaS)	36
Artificial Intelligence	19
3D printing	11
CleanTech	10
Internet of Things	9

Source: SQW analysis of Beauhurst data

8.10 Of the 243 beneficiaries, 105 (43%) are 'tracked' by Beauhurst due to meeting a 'tracking trigger', signalling either a high growth or ambition to achieve it.[58] For comparison, the proportion of

[58] A company is 'tracked' by Beauhurst when it meets one of the following tracking triggers: securing equity investment, securing venture debt, undergoing a management buyout or buy-in, attending a selected accelerator programme, scaleup status, spinning out of an academic institution, being featured in a high growth list or accepting a large innovation grant.
See: [What are the Beauhurst Tracking Triggers? | Beauhurst Help Center]

businesses in the wider business population that are tracked is under 10%, and for businesses that have the same sector focus as the MSI Challenge, the proportion is below 1%. Additionally, 27 beneficiaries are featured on Beauhurst's 'high-growth list', which further validates the ambition and growth prospects of featured companies.

Location, age and size

8.11 The MSI Challenge supports SMEs across all regions of the UK and the regional distribution largely mirrors the geographical distribution of UK companies from the sectors of the economy supported by the programme. There is a skew towards London (23%) and only 1% of beneficiaries are registered in Wales (Figure 8-2). London and Northern Ireland are overrepresented on the programme by c. 4.5%. The Northern Ireland figures may be influenced by the location of the lead partner in the consortium delivering the Smart Manufacturing Data Hub being based there (the University of Ulster).

8.12 The MSI Challenge has supported a wide range of companies, from young to more established, although most of the beneficiaries are relatively new firms. At the time of their first engagement with MSI, the median age of the SMEs was eight years, approximately a third of them had been operating for under five years and another fifth for under a decade. Figure 8-3 presents the distribution of age at the time of support.

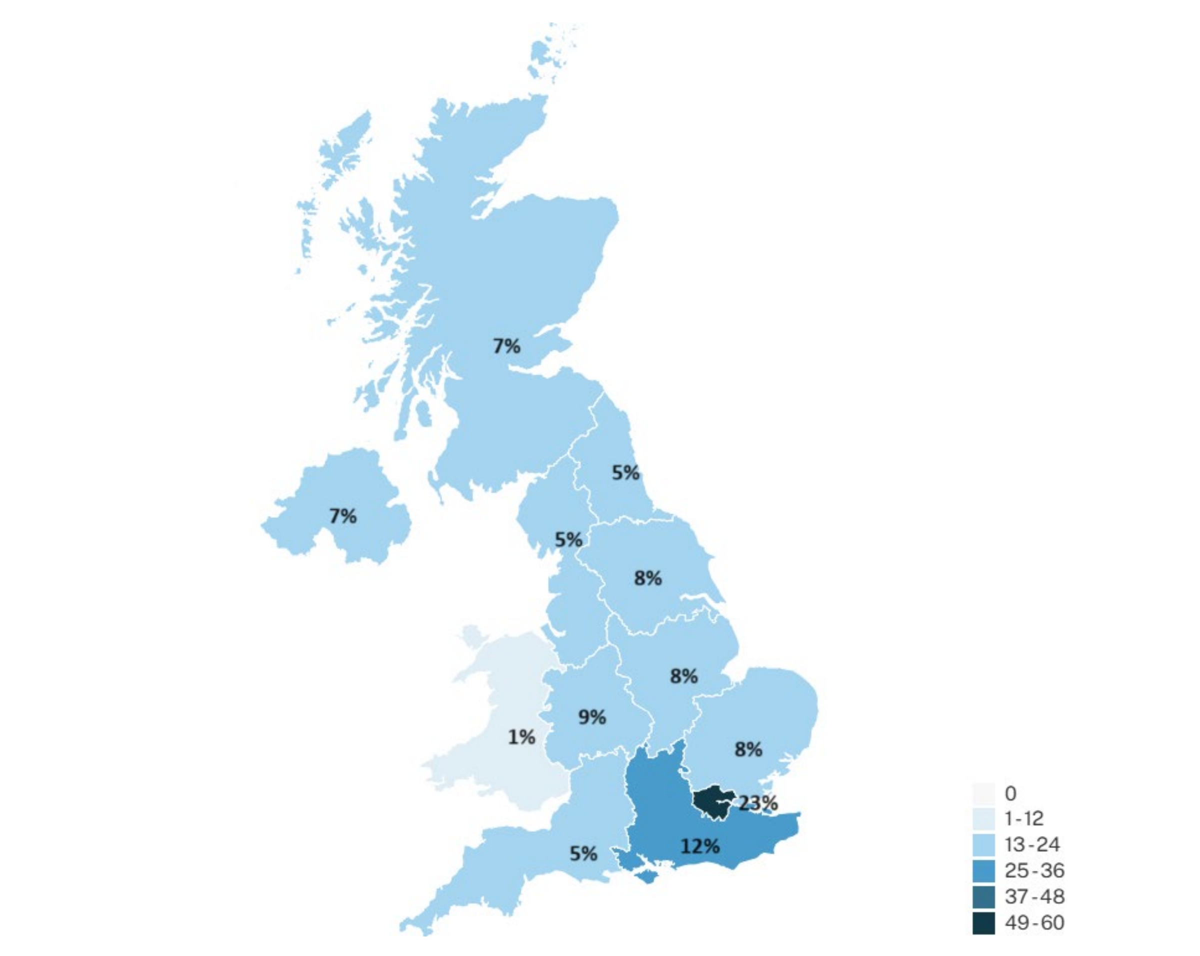
8.13 Table 8-3 summarises available information about the pre-treatment size of the beneficiaries.[59] Turnover figures are based on information from the BSD.[60] Employment data is available both in Beauhurst (self-reported by companies) and BSD (based on Pay as You Earn tax records and, in some cases, the Annual Business Survey).[61]

[59] The table shows values for a typical (median) firm. In other words 50% of the population were smaller. This measure of the centre of the distribution is less affected by outliers than the arithmetic mean. Based on Beahurst data, the mean of turnover is £38.2m and mean of employment is 45. Using BSD data, mean of turnover is £41.9m and mean of employment is 155.

[60] Only companies with turnover exceeding £10m are obliged to disclose it to the Companies House. As a result, there are only 58 pre-treatment observations on turnover in Beauhurst and median value is quite large at £17.7m.

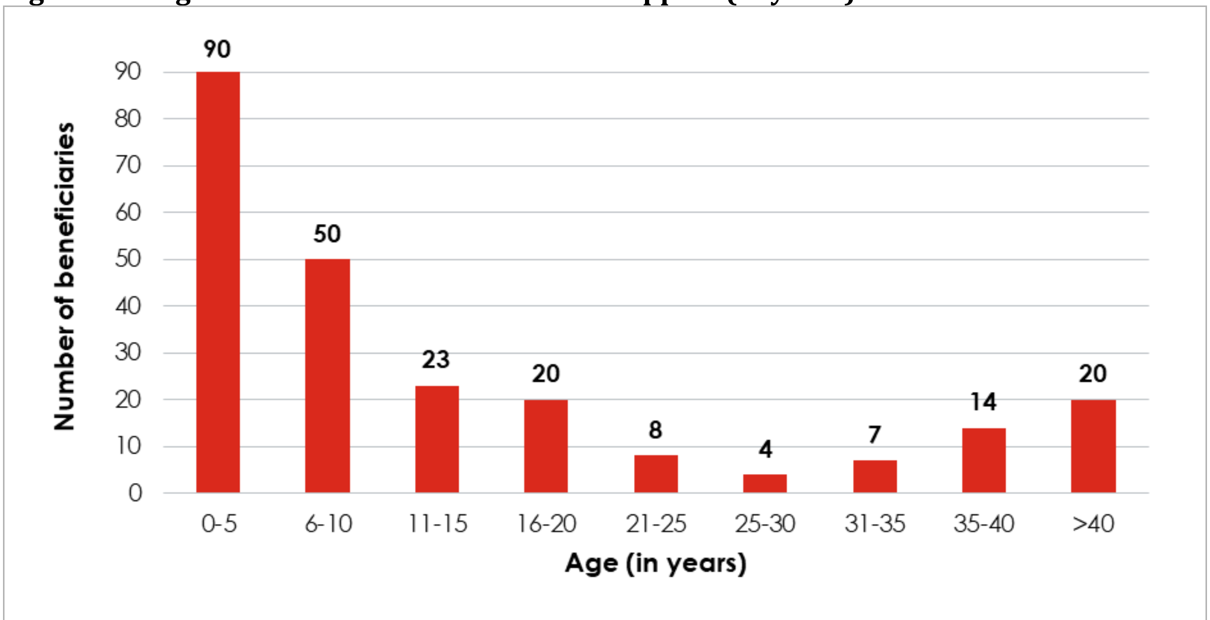
[61] Data linking to BSD was performed by the IDBR team. Analysis in SRS is fully anonymised and there is a chance that a company gets linked to its parent or a group of firms. The similarity in the employment data (in terms of median employment) from Beauhurst and BSD gave us confidence that the linking was successful. The differences are likely due to reporting standards (e.g. employees vs total headcount, including owners or founders).

Figure 8-2: Geographical distribution of beneficiaries



Source: Beauhurst. Note this map is based on those beneficiaries that had a Beauhurst record so it describes a subset of the beneficiaries mapped in Figure 5-5.

Figure 8-3: Age of beneficiaries at the time of support (in years)



Note: Age at the time of support was calculated as the difference between a business's year of support and its year of incorporation. For a few beneficiaries, the incorporation date is later than the date of their first engagement with the MSI, possibly due to restructuring
Source: SQW analysis of monitoring and Beauhurst data

Table 8-3: Average pre-support size of beneficiaries

	Beauhurst	BSD
Turnover (median)	Data insufficient	£0.96m (n=177)
Employees (median)	19 (n=170)	12 (n=177)

Source: SQW analysis of Beauhurst and BSD data

Comparison groups

8.14 We used two complementary comparison groups:

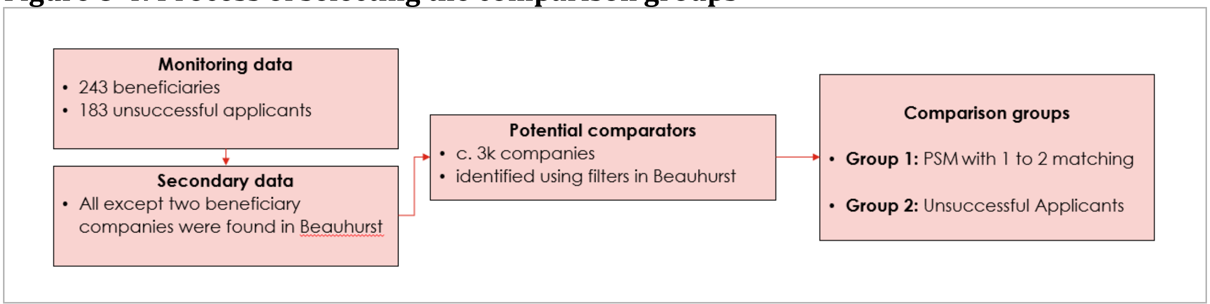
- **Group 1**: a group of unsupported companies from the wider business population selected using a 1:2 Propensity Score Matching (PSM).[62]
- **Group 2**: unsuccessful applicants for MSI (UAs).

8.15 Considering these two comparison groups allowed us to triangulate the likely true effect of support as these groups have contrasting strengths and weaknesses. PSM is typically very effective in selecting the most similar comparator businesses based on their observable characteristics, such as age, sector, location, etc., but it cannot guarantee a good match on unobservable (or observable but not recorded) characteristics. At the same time, UAs are likely to be similar to beneficiaries on unobservable characteristics such as propensity to seek support, motivation, attitudes to risk and management style, all of which tend to correlate with outcomes. However, these firms were not accepted to the programme meaning either the businesses themselves or their projects may have been substantially different from the beneficiaries.

Selecting the comparator companies

8.16 Selecting the matched comparison group was a two-step process summarised in Figure 8-4. Our analysis of monitoring data revealed that there were over 180 companies that applied for support from the MSI programme, but were not successful. Therefore, any changes in their business performance could not be attributed to the programme. We chose these companies to act as the UA comparison group (Group 2).

Figure 8-4: Process of selecting the comparison groups



[62]PSM is a statistical technique that selects like-for-like unsupported companies based on how likely they would be to receive the support judging by their observable characteristics.

8.17 Given the focus of the programme on enabling R&D and on the manufacturing and digital economy sectors, when selecting comparators from the wider business population (Group 1) it was important to mirror the innovation and sector profiles. To achieve this, we first linked the monitoring data to information in Beauhurst and undertook descriptive analysis of the beneficiary and wider business populations. This analysis allowed us to identify c. 3,000 potential comparator companies that met broad selection criteria (these are outlined in the Annex Report).[63]

8.18 The next step involved using PSM to identify the most like-for-like comparator companies by taking into account a wider range of characteristics.

- First, we estimated a matching statistical model that predicted the likelihood of being a beneficiary based on observable characteristics – the 'propensity scores'. Effectively, propensity scores blended all characteristics we chose to match on in one measure of similarity. Table 8-4 lists the characteristics that were used in the matching model.[64]

- Second, for each beneficiary, we selected two non-beneficiaries with the closest propensity scores, yielding the 1:2 matched comparison group. Further detail on the matching as well as on validation checks undertaken is available in the Annex Report. This also contains headline profiles of the two comparison groups: matched comparators and unsuccessful applicants.

8.19 Overall, our conclusion was that PSM had successfully reduced imbalances between the beneficiaries and potential comparators across the matching characteristics and provided us with a high quality comparison group.

Table 8-4: Observable characteristics used for statistical matching

Characteristic
Sector (SIC 2007 Section)
Region
Firm age
Beauhurst tracking status (tracked, non-tracked, ceased tracking)
High growth marker (Beauhurst classification)
Being associated with at least one Buzzword

[63] We assigned each of those companies a quasi-treatment year and made sure the distribution of those years matched the time profile of support.
[64] There is a trade-off between the number of variables in the matching model and the number of beneficiaries/comparator firms the model can include. This is because not all information is available for all the companies. We tested multiple matching specifications and compared the results, landing on the list of variables presented in this section. Indicators of pre-treatment size (e.g. employment) are often viewed as important matching characteristics. However, including them lowered the sample of beneficiaries by 30% without any substantial effects on the overall quality of the comparison groups, including the similarity of pre-treatment trends to the beneficiaries.

Characteristic
Number of firms in the corporate structure
Whether the company is the ultimate 'parent' in the corporate structure
Credit rating

Source: SQW

Difference-in-difference analysis

8.20 The data on firm-level outcomes comes from the Business Structure Database (BSD). Table 8-5 presents the number of companies available for the analysis (by group). We were able to link data on 95% of beneficiaries, 90% of comparators and c. 80% of unsuccessful applicants.

Table 8-5: Number of companies by group in the BSD

Beneficiaries	Group 1: Matched comparators	Group 2: Unsuccessful Applicants
232	376	147

Source: SQW analysis of BSD data

8.21 Our choice of specific statistical models was informed by recent academic discussions of the pros and cons of alternative specifications, including the publications by Goodman-Bacon (2021), Callaway and Sant'Anna (2021), Sun and Abraham (2021), Roth et al. (2023).[65] Specifically, we considered two types of DiD models: the first one investigates the average impacts across all years following the support, the second estimates the impacts in each year after support separately (a so-called 'event study').[66] In general, since approximately half of the beneficiaries were supported from 2021/22 onwards, the samples underpinning the event study estimates were too small to rely on them as main evidence of impacts. We used these models primarily to sense-check the findings form the main models.

8.22 For the purposes of impact analysis, we defined the date of support as the first recorded interaction between the SME and the MSI programme (as per monitoring data). The analysis investigates the effects following the first interaction with the programme, including in the financial year when the support started. All statistical analysis was performed in 'R' with an extensive use of the core functionality (R Core Team, 2023), as well as the 'dplyr' (Wickham,

[65] Goodman-Bacon, A., 2021; 'Difference-in-differences with Variation in Treatment Timing'. Journal of Econometrics, 225(2), pp.254-277; Callaway, B. and Sant'Anna, P.H., 2021; 'Difference-in-differences with Multiple Time Periods.' Journal of Econometrics, 225(2): 200-230; and Sun, L. and Abraham, S., 2021; 'Estimating Dynamic Treatment Effects in Event Studies with Heterogeneous Treatment Effects'. Journal of Econometrics, 225(2): 175-199; Roth, J., Sant'Anna, P.H., Bilinski, A. and Poe, J., 2023; What's trending in difference-in-differences? A synthesis of the recent econometrics literature. Journal of Econometrics, 235(2), pp.2218-2244.
[66] Further detail on the two DiD models is available in the Annex Report.

2023), 'Matching' (Sekhon, 2011), 'cobalt' (Greifer, 2024) and 'ggplot2' (Wickham, 2016) packages.[67]

8.23 When estimating the models, we tested the data for pre-existing groups trends that should not be attributed to support e.g. whether the beneficiaries on average were on a steeper growth trajectory than the comparison groups even before treatment. When present, such differences should not be attributed to the support. In the cases where the pre-support trends could be statistically significantly different between the groups, we controlled for the differences.

8.24 Furthermore, all our DiD models controlled for firm specific unobservable characteristics that are constant over time as well as for the general macro-economic conditions affecting all companies in the economy in a given year. To aid statistical properties of the models, all outcomes measured were analysed in logarithmic terms. Standard errors were adjusted to account for the fact that observations over time are not independent of each other. For example, if a company experiences additional growth in the first year following the support, the positive trend for this firm may be more likely to continue the following year. Furthermore, since many MSI funded projects involved multiple beneficiaries, standard errors were also adjusted to reflect the fact that outcomes could be correlated across the firms.[68] Turnover was analysed in real terms (i.e. adjusting for inflation, in 2023 £s).

8.25 In the remainder of this section, we present the findings by outcome measure: employment and turnover.

Employment

8.26 On average, following MSI support, the employment of beneficiaries tends to be c. 14% higher that the counterfactual trajectory established by similar companies from the wider business population (Table 8-6). This is on top of a further c. 3% pre-existing difference against that group which cannot be attributed to the support. The impact estimate is of a similar magnitude (15%) when unsuccessful applicants are used as a comparison group.[69] Further detail on this result including graphical analysis is presented in the Annex Report.

[67] R Core Team, 2023. R: A Language and Environment for Statistical Computing. Vienna, Austria: R Foundation for Statistical Computing; Wickham, H. et al., 2023. dplyr: A Grammar of Data Manipulation; Sekhon, J.S., 2011. Multivariate and propensity score matching software with automated balance optimization: the matching package for R. Journal of statistical software, 42, pp.1-52.; Greifer, N., 2024. Covariate balance tables and plots [R package cobalt version 4.5. 5]. Epub ahead of print April, 2; Wickham, H., 2016. ggplot2: Elegant Graphics for Data Analysis. s.l.:Springer-Verlag New York.
[68] Such correlations are known as cross-sectional dependencies. Our tests confirmed their presence in the data and therefore we used standard errors clustered both at the business and year levels.
[69] The percentage effect can be obtained by exponentiating the regression coefficients presented in the tables.

Table 8-6: DiD results – employment effects

	Group 1: Matched comparators	Group 2: Unsuccessful Applicants
Av. % effect of support	14%	15%
DiD coefficient	0.127 * (0.077)	0.143 * (0.081)
Pre-existing trend	0.030 ** (0.015)	Not significant (excl. from the model)

*Note: two-way cluster robust standard errors in parentheses, asterisk represent statistical significance * p<0.1, ** p<0.05*
Source: SQW analysis of BSD data

8.27 Results from the event study DiD regressions validate our findings from the main models (see Annex Report). There is a statistically significant effect on employment of c. 14%-16% in the year of the support that can be attributed to the support. This suggests that employment effects are quick to come through. The point estimates in the following years are not statistically significant, however considering the results from the 'average' model, this is likely due to smaller sample sizes underpinning those estimates.

8.28 In Section 9, we discuss what these DiD estimates of employment effects represent in terms of the absolute change in employment of a typical firm and the total number of jobs generated by the programme.

Turnover

8.29 The findings from our regression analysis are shown in Table 8-7. At this point in time, we found no statistically significant effect from the support on turnover when comparing outcomes of beneficiaries to those of the matched comparison group. However, in the post-support period, the turnover of beneficiaries is on average about 23% higher than for unsuccessful applicants. In both cases there seem to be no pre-existing differences in trends between the beneficiaries and the comparison group. Further detail on the effects of turnover growth is presented in the Annex Report.

Table 8-7: DiD results – turnover effects

	Group 1: Matched comparators	Group 2: Unsuccessful Applicants
Av. % effect of support	Not significant	23%
DiD coefficient	0.075 (0.091)	0.208 ** (0.097)
Pre-existing trend	Not significant (excl. from the model)	Not significant (excl. from the model)

*Note: two-way cluster robust standard errors in parentheses, asterisk represent statistical significance * p<0.1, ** p<0.05*
Source: SQW analysis of BSD data

8.30 Results of the event study DiD regressions confirm the findings above (these can be found in the Annex Report). There are no statistically significant treatment effects on turnover when comparing outcomes of beneficiaries and matched comparators. When comparing outcomes of beneficiaries and unsuccessful applicants, there are statistically significant effects on turnover in the year of the support and one year after the support of c. 24%-25%.

Reflections

8.31 The main limitation of the DiD analysis is the small number of post support observations. Considering that data on turnover in the year following the start of support was available only for just over half of beneficiaries means that our results reflect the short-term outcomes rather that represent a complete picture of ultimate impacts.

8.32 The patterns in results are typical for innovation focused programmes – quick statistically significant employment effects which may translate into measurable differences in turnover and productivity if the projects are successful and the developed products/services penetrate the market. The employments differences between the beneficiaries and comparator companies is the most robust of our findings and informed our preliminary assessment of the value for money (see Section 9).

8.33 At this stage, we could not confirm the turnover impacts relative to a well-matched group of similar unsupported companies. However, a gap relative to unsupported applicants was observed. This finding can be interpreted as evidence that MSI is successful in selecting the companies and projects to support. It also provides some degree of confidence that over a longer period of time, the support may lead to statistically significant differences relative to the matched comparison group as well. This conjecture, however, needs to be confirmed with further analysis when more data becomes available. That additional analysis may also shed light on whether the positive turnover and productivity impacts are common across the beneficiaries or highly concentrated within a few of the most successful projects.

9. Value for money

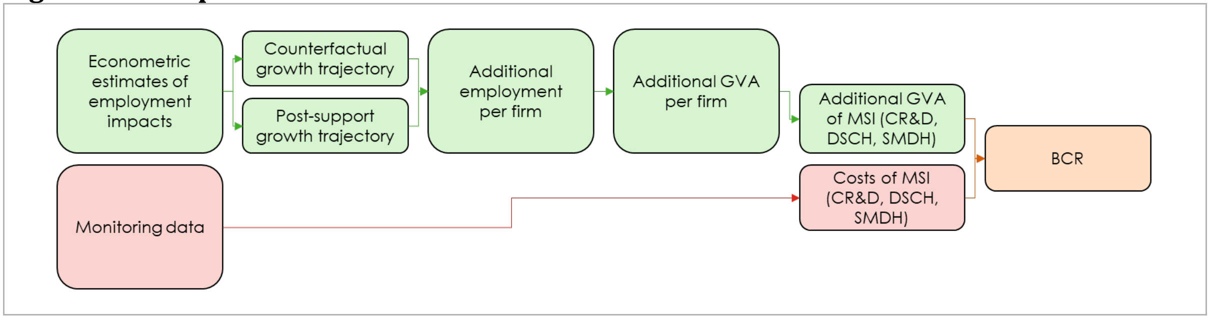
Summary

- The benefits for SME beneficiaries were estimated over four years (the year of support and up to three following years). This means the analysis covered the period from 2019/20 to 2027/28 financial years, and included realised and expected benefits.
- The MSI Challenge has resulted in **c. 580 jobs** across 243 SME beneficiaries in scope for the evaluation. This is based on a typical (median) beneficiary firm creating 2.4 additional jobs due to MSI support i.e. c. 14% higher employment than it would have been otherwise (as reported in Section 8 – note this is different to the 459 jobs reported in programme monitoring data).
- The present value of benefits for the 243 SME beneficiaries in scope was estimated to be **c. £168m in GVA** (nearly all of this has been achieved already).
- The present value of economic costs was estimated to be £77m relating to the strands supporting businesses (CR&D, DSCH, SMDH).
- We estimate that the MSI Challenge has a **benefits-to-costs ratio (BCR) of 2.2** i.e. for every £1 of public investment into the Challenge, on average the beneficiaries are expected to generate c. £2.2 in GVA. This represents good value for money.
- The analysis presents a partial view of the value for money based on short-term impacts of the programme on employment of beneficiaries.

9.1 This section presents an early assessment of value for money associated with the MSI Challenge. This is based on the econometric analysis of the net impacts of the MSI Challenge on beneficiary companies and the costs of delivering the Challenge. In arriving at an assessment of value for money, we highlight the following: the employment impacts from Section 8 have been converted to Gross Value Added (GVA); the assessment relates to a subset of MSI Challenge activities i.e. MSI streams that supported SMEs (CR&D, DSCH, SMDH); all estimates for the benefits-to-costs (BCRs) presented in this section should be seen as indicative.

9.2 Figure 9-1 summarises the process we followed to arrive at the estimate of net additional GVA and its ratio to the associated costs.

Figure 9-1: Steps in VfM assessment



Source: SQW

Estimating GVA

9.3 We based our estimate of net additional GVA attributable to the programme on the econometric estimates of employment effects of MSI on its beneficiaries.[70] The job creation was considered over a four-year period (the year of support and the three following years). This time horizon was based on the longest span of observations available on beneficiary SMEs in our regression model – therefore it was the longest time period we could apply our estimates to.

9.4 To calculate the additional jobs created in a typical (median)[71] beneficiary firm we approximated two employment paths: the counterfactual one that the company would have likely followed in absence of MSI; and the post support trajectory. The counterfactual growth path was based on the average growth observed among the comparator companies used in the econometric analysis (7% per year) and unattributable pre-existing difference between the beneficiaries and comparators (3%). The post-treatment trajectory was higher than the counterfactual path by 14% (the average treatment effect from MSI support across all post-support years). The parameters underpinning the growth trajectories are summarised below.

Table 9-1: Parameters determining the counterfactual and post-treatment employment

Variable	Value
Typical pre-treatment employment of beneficiaries (median)	12 employees
Counterfactual growth (annual rate)	7%
Pre-existing non-attributable growth of beneficiaries (annual rate)	3%

[70] We chose this approach as opposed to quantifying GVA via additional turnover due to the lack of consistency in the estimates of turnover impacts at this point in time (there was positive gap relative to UAs, however no statistically significant differences relative to the matched comparison group). The estimates of employment effects are more robust.
[71] A typical firm for this analysis was taken as the median, in other words a firm in the middle of the distribution where 50% of the population are smaller. The median was preferred over the mean since the mean is substantially more sensitive to outliers and is less representative of the beneficiary population when it comes to aggregation of the impacts to the programme level.

Variable	Value
The average additional employment following the support (the effect of MSI)	14%

Source: SQW

9.5 The net additional employment created in each of the four years was calculated as the difference between the trajectories. On average, each beneficiary was predicted to have created 2.4 additional jobs, 1.8 of which would be generated in the year of support.[72]

9.6 The average GVA created by each of the jobs per year was estimated to be £82,300 (in 2023 £s) based on ONS GVA per job figures,[73] taking into account the sector composition of beneficiaries.[74] Unlike employment itself, the additional GVA created as a result of it is a cumulative benefit: within our model the jobs created in the year of support generate the GVA over four years, the jobs created in the year following the start of the support over three years, etc.

9.7 Our estimates for the number of additional jobs per beneficiary and associated GVA are given below (Table 9-2).

Table 9-2: Employment and GVA impacts per beneficiary

Year relative to the year of support (t)	Counterfactual employment	Employment with the effect of the support	Change in employment attributable to the support	Additional GVA associated with the employment (per firm, £s)
t	13.2	15.0	1.8	£600k
$t+1$	14.5	16.5	0.2	£44k
$t+2$	15.9	18.1	0.2	£32k
$t+3$	17.4	19.8	0.2	£18k
Total			**2.4**	**£694k**

Source: SQW.

9.8 The final step in the calculation of the GVA benefits at the programme level involved aggregating the impacts across the 243 SMEs in scope. The total additional GVA generated through employment as a result of MSI support was estimated to be **c. £168m.**

9.9 Our calculations at this step accounted for the fact that beneficiaries received support in different years and that some of the outcomes for some of the beneficiaries are still expected. The

[72] Note that the estimate for created jobs is not an integer (not 'round'). This is because it represents the 'average' path, some companies will created more jobs, some fewer.
[73] ONS Output per job (UK) dataset, released 18 February 2025, Table 12: 'Annual Output per job by section-level industry aggregations, Current price (CP) in GBP'.
[74] The GVA per job is estimated using the analysis set out in Section 8. It is the weighted average of GVAs per job in the beneficiary sectors e.g. 33% of beneficiaries were from manufacturing and so the GVA per job had 33% weight in the overall estimate for the GVA per job.

additional GVA expected to be realised beyond 2024/25 financial year was discounted at 3.5% per year (the social time preference rate, as per the Green Book).[75]

Costs

9.10 To ensure a fair comparison between the costs and benefits, our assessment took into account only the costs associated with the strands of MSI that supported the companies used in the econometric analysis of impacts. These costs are presented in Table 9-3. Note that we considered the amount spent on activities rather than the budget initially allocated to them.

Table 9-3: Cost of the support in scope of VfM

MSI strand	Amount spent (£m)
Collaborative R&D (CR&D)	46
Digital Supply Chain Hub (DSCH)	12
Smart Manufacturing Data Hub (SMDH)	19
Total	77

Source: SQW analysis of MI data

BCR and reflections

9.11 Table 9-4 summarises key findings from the VfM assessment. Based on the econometric analysis of impacts on supported SMEs and the costs associated with the support, the approximate BCR is 2.2 i.e. for every £1 of public investment into the programme, on average the beneficiaries are expected to generate approximately £2.2 in GVA for the economy.

Table 9-4: Summary of VfM findings

Metric	Value
Total jobs (created and expected)	583
Total GVA (created and expected)	£168m
Cost of the support (relevant MSI strands: CR&D, DSCH and SMDH)	£77m
Benefits-to-costs ratio	**2.2**

Source: SQW

9.12 It is important to highlight that our analysis presents a partial view of value for money. Specifically, it only considered the direct GVA benefits generated by the beneficiaries of a subset of activities. Wider impacts of the programme are not captured by this assessment. Furthermore,

[75] The derivation of aggregate impacts with appropriate discounting can be found in the Annex Report.

as discussed in Section 8, the benefits are a result of short-term near immediate effects rather than a reflection of ultimate long-run impacts of the programme on the beneficiaries.

9.13 Overall, in our view **MSI represents good value for money to date**. However, a fuller picture will emerge once the supported projects and technologies have had more time to commercialise, penetrate the market and generate additional turnover and productivity benefits.

9.14 It is important to highlight that the analysis presented in this section did not explicitly account for displacement.[76] This is because the GVA was approximated through the short-term employment effects of MSI, and it was not possible to accurately estimate potential displacement from employment based on available evidence (including the survey). Considering the nature of supported businesses and the skills they require, it is likely that in absence of MSI, the new employees of beneficiary firms would have been employed elsewhere. However, it will be more appropriate to estimate the degree of displacement from their activities when the new products reach the market, and it is revealed whether any competition has been displaced and if so, where it is located (UK versus overseas).

9.15 Related to the above, we consider the estimates of the GVA benefits obtained through the employment calculations to be early approximations of potential impacts that may be achieved through additional sales and productivity improvements in the future. Nearly all surveyed beneficiaries reported that their technology had advanced to a higher TRL due to their MSI-funded project. More than half of the respondents indicated that their technology had progressed by at least three TRLs, and over one third were able to reach deployment stages (TRL 7-9). These results increase our confidence that the short-term employment effects can be converted into sustained GVA streams in the longer run.

[76] The econometric DiD analysis provides estimates of net impacts but does not fully account for displacement.

10. Conclusions

Summary

10.1 The Made Smarter Innovation programme has been a significant investment in encouraging innovation through emerging digital technologies. It has operated through a period of considerable challenges that impact both on its delivery and on the ability of participating businesses to maximise the potential benefits. Despite some delays, the Challenge has been able to deliver a substantial, complex and wide-ranging set of interventions. The Challenge achieved private sector match funding of £100m compared to a grant spend of £112m and attracted a further £102m in private follow on funding. It has exceeded all its original activity and output targets, engaging over 400 SMEs and generated 356 IDT solutions for adoption by manufacturers. There has also been considerable activity in developing networks, university research collaborations and building up the two MSI Hubs.

10.2 The evaluation has shown how the Challenge has delivered successfully against the logic model up to 2025. The programme impacts were expected to build up to 2030-35. It is too early to measure how the adoption of this innovation activity will eventually impact on turnover and exports, but the beneficiary survey and econometrics provide a good indicator. The survey of beneficiary firms found that 80% have achieved (or expect to achieve) an increase in jobs, turnover or productivity, as a result of MSI-funded projects. The econometric analysis finds a significant and positive impact on employment (around 580 jobs across 243 SME beneficiaries) as firms have recruited to support innovative activity. This represents just over half the SMEs the Challenge engaged, but it provides some direct evidence of the programme's economic impact. We would expect to see the impact grow further as more solutions are implemented.

10.3 Realising the potential of the investment will now depend on how effectively IDTs are adopted, not only by those participating in the Challenge, but in the sector more widely. There are signs that the wider environment for manufacturing will continue to be difficult, with higher taxes domestically and new tariff regimes internationally. It serves to reinforce the important roles of both MSI and the Made Smarter Adoption programme.

10.4 In the remainder of this section, we address each of the evaluation research questions and then provide our overall assessment against the MSI programme logic model.

Addressing the research questions: to what extent and how was the Challenge successful in…

Increasing the UK manufacturing sector investment in industrial digitalisation R&D?

10.5 The Challenge generated £100m in private sector match-funding for its activities, primarily on CR&D and the Innovation Hubs, as well as a smaller amount on the Research Centres. It also stimulated additional private sector investment (beyond match funding) of £102m across these three workstreams for activity following on from Challenge-funded initiatives. Taken together, this £202m investment exceeded target by £40m.

10.6 This is an encouraging set of results given the biggest barrier to innovation, as identified by beneficiary survey respondents, was difficulty securing finance (65% respondents). This indicates that match-funding was key to unlocking investment in IDTs. Subsequent investment then followed the success of particular projects or positive collaborations that went on to explore a slightly different technology. Consultation and case study evidence provides a range of instances where this occurred, such as Lockheed Martin's lead on follow-on investment into Q5D Technologies after collaboration on a project about 3D circuit technology, which progressed from proof of concept to lab validation. The increased investment is also likely to be underpinned by a growing understanding of the application of IDTs, as reported by most beneficiary survey respondents, as well as tangible outcomes such as increased jobs, turnover and productivity, as experienced by more than half of respondents.

Increasing the adoption of new IDTs?

10.7 The Challenge has made good progress on increasing the adoption of new IDTs: programme monitoring data record over 600 businesses as having adopted innovative digital solutions as a result of the programme. The Challenge has done well at generating those IDTs for adoption, with a strong set of technology and innovation outputs in terms of technology solutions, demonstrators, use cases, and publications to its credit, as evidenced by monitoring data, survey responses and qualitative feedback. For example, MSI generated 356 IDT solutions for manufacturers against a target of 100, 334 demonstrators against a target of 20, and 39 IP applications, plus nearly half of beneficiary survey respondents reached deployment stages (TRL 7-9) for their technology. The CR&D projects, Innovation Hubs, Research Centres and Accelerators have all played a role in developing IDTs and encouraging adoption. The Hubs, in particular, made significant efforts to foster uptake of IDTs through creating virtual platforms to make technologies such as data analytics more accessible.

10.8 Yet this evidence describes MSI's achievements in relation to adoption of technologies within specific settings and for specific manufacturing processes in relation to specific interventions. Consultees were more cautious about the influence of the programme in delivering more widespread adoption of IDTs. Indeed, the Challenge only managed to reach a small proportion of the 270k manufacturing firms, even if the MSI Network reached over 15,000 with its newsletter. The scale of the barriers to adoption that were the rationale for the Challenge persist, including low levels of digital maturity in the manufacturing sector, particularly among SMEs. The Challenge was very active and successful in supporting the development of IDTs, and initial adoption is evidence of the quality and appropriateness of those technologies among Challenge participants and their supply chains. Insights from InterAct and the People-Led Digitalisation Research Centre relating to human-centred IDT development and adoption are also of value and warrant further exploration. However, the issue of wider adoption across the manufacturing sector arguably sits outside the MSI Challenge, with other programmes, such as Made Smarter Adoption, and other agencies.

Increasing the cross-sector collaboration between different academic disciplines, businesses and academics, and different businesses within the UK manufacturing sectors to avoid duplication and maximise IDT applications?

10.9 There is considerable evidence to demonstrate how effective the Challenge has been in enhancing cross-sector collaboration between academia and industry and among businesses. The CR&D competitions were a key route to facilitating collaborations. Together they generated 894 collaborations, of which 174 were partnerships between business and academics and 185 were collaborations between manufacturers and technology companies. CR&D projects covered a range of technologies (not mutually exclusively) including AI/machine learning (38), digital twins (31), IoT (28), robotics (16) additive manufacturing (8), distributed ledger technology (6) and one project related to extended reality.

10.10 The Research Centres and InterAct also played a key role in fostering academic collaboration. The former brought in an additional 76 academics (not part of the funded consortia) and InterAct worked with 40 universities and organised 35 events, amplified by the Network's 61 events that enabled over a thousand introductions. One instance of the result of this collaboration is the more than two hundred publications produced by the Research Centres.

10.11 This success on driving collaboration, and the positive feedback on the experience of cross-sector collaboration, both from interviews and the beneficiary survey (in which three-quarters of respondents reported an increased willingness to pursue collaborative research partnerships), is welcome given that barriers to finding appropriate collaborators was one of the most significant barriers to IDT innovation, particularly for digital technology developers (as reported in the beneficiary survey). There was strong evidence, in both the survey and qualitative feedback, regarding the role of collaboration in contributing towards outcomes and impacts. Over 90% beneficiary survey respondents indicated that inputs from project partners had helped the realisation of project benefits and that collaboration was important to the outcomes generated.

Increasing the number of digital technology companies providing solutions for manufacturing industries and providing UK sourced solutions at appropriate business scale?

10.12 The Challenge has exceeded the target set for increasing the number of digital technology companies providing solutions to manufacturing industries. The Challenge had a target of two spin-outs or start-ups as a measure of progress on this objective and reported 15 by the end of the programme. Even among the small beneficiary survey sample, two respondents reported their project led to a spin-out and five others expected new companies to emerge in the future.

10.13 Creating new digital technology companies was considered a priority because of the perceived low level of IDT development and adoption among UK manufacturing. Increasing the number of companies in this space is undoubtedly helpful. Yet there are other examples within the Challenge as to how it has stimulated this sector. The Accelerators, for instance, were specifically designed to bring digital technology companies together with major UK manufacturers to address the specific challenges facing those large manufacturers. In total, the two completed Accelerators delivered 28 prototypes and 8 MVPs. Perhaps even more importantly, some of the interactions resulted in ongoing partnerships, as between BAE Systems and Machine Intelligence, an AI provider.

10.14 Overall, MSI made progress on developing the ecosystem for IDT development and adoption both by stimulating the creation of new digital technology companies but also by providing opportunities for existing digital technology companies to collaborate with manufacturers and learn about respective needs, skills and expertise.

Increasing the number of collaborations between SMEs and larger, more established companies up the value chain?

10.15 The Challenge has been successful in facilitating collaborations between SMEs and larger, more established companies. Through the CR&D competitions, the Challenge facilitated 198 partnerships specifically between SMEs and large firms and, as described above, the Accelerators were designed to foster collaboration between small digital technology companies and large UK manufacturers. The Innovation Hubs also engaged with 168 SMEs and 89 large companies. More broadly, the Challenge had a specific target to engage at least 200 SMEs. Combining SMEs engaged across the CR&D projects, the Innovation Hubs and the Research Centres, it doubled this target, engaging over 400 SMEs.

10.16 As noted earlier, barriers to finding the right collaborators was a key issue underpinning the rationale for the programme. By providing multiple opportunities for companies to collaborate, particularly for SMEs to engage with larger companies, the programme tackled a key barrier to innovation. The opportunity to collaborate was partly enabled by funding, for example to participate in a CR&D project, but also by the networking opportunities and brokering service offered by various strands of the programme, in particular InterAct and the Network.

Increasing the UK manufacturing and digital manufacturing solution exports through demonstrable capabilities and products?

10.17 The Global strand of MSI was significantly reduced early on due to the challenges of international collaboration in the context of the Covid-19 pandemic (for example due to travel restrictions) and wider Innovate UK budget constraints. Yet, to date, the Challenge has recorded £4.26m exports, which indicates that there is some potential for exports of the technologies and products developed but more may arise over the next few years depending on developments in the international context. As the Challenge has a portfolio of technological and innovation outputs, there is potential to encourage adoption of these both internationally and within the UK. The increased skills developed among many Challenge participants will support efforts to capitalise on the achieved technology outputs although there is clearly scope to do more on digital maturity across the wider UK manufacturing sector.

Assessment against the MSI programme logic model

10.18 The MSI Challenge has performed very well in delivering activities and translating these into outputs in line with the programme logic model. The Challenge met or exceeded nearly all activity and output targets. It engaged with a range of SMEs and delivered a large number of collaborations. The Challenge has led to technology and innovation outputs, and private investment. Key to successful delivery has been a well-executed CR&D model and through stimulating interest and engagement via more novel intervention models (e.g. Innovation Hubs and the Research Centres). The activities have addressed the programme rationale and objectives – and spending has been managed appropriately across the seven workstreams. The evidence points to scale and quality of delivery over five years, especially in a challenging external environment.

10.19 The Challenge activities and outputs have been translated into short term outcomes as identified in the logic model (and expected by 2024/25). It has delivered against all of the short-term outcomes identified within the logic model, including raising awareness of IDT uses and benefits, supporting TRL progression and adoption, stimulating follow-on funding, and increasing IDT related skills. There is also evidence that short term outcomes are starting to translate into longer term outcomes (i.e. those expected from 2026/27 onwards) such as increased employment, and sustainability outcomes, with some examples of reductions in waste, energy and $C0_2e$ among specific projects.

10.20 Importantly, the evaluation evidence indicates medium-to-high additionality for MSI. The Challenge helped to increase the speed, scale and quality of outcomes. These beneficiary survey results are supported by the findings from the case studies and feedback from unsuccessful applicants, for whom not receiving funding slowed down/held back their growth. The latter reinforces the additionality of MSI. Furthermore, most beneficiaries thought MSI made a critical or important contribution to achieving outcomes alongside other factors.

10.21 The two key mechanisms that helped translate outputs into outcomes within the programme lifespan were grant funding to de-risk and lever investment into innovation and collaboration to stimulate more innovative and relevant technologies. Conversely, progress towards outcomes was affected by a challenging economic and market context, delays in mobilising key workstreams (notably the Smart Manufacturing Data Hub and to a lesser extent the Research Centres), pressures on programme team capacity, and low levels of digital maturity which hindered engagement with SME manufacturers and are likely to influence wider adoption of innovations.

10.22 The results from the econometric analysis indicate that the MSI Challenge has had positive statistically significant impact on the employment of beneficiary companies. Comparing the positive employment and GVA results with the relevant costs of the programme suggests that the MSI Challenge has been good value for money so far. This is particularly impressive given the wider difficult environment in which MSI has been delivered; this includes the UK and international trends in the manufacturing and digital technologies sectors, and the uneven technological progress across the five core IDTs.

Lessons for future interventions

10.23 We identify the following areas of learning:

- UKRI can play an important role in de-risking investment into innovation, where levels are lower than desirable from a public policy perspective. The use of CR&D competitions and Accelerators proved to be attractive ways to do this for MSI.
- A key outcome has been collaboration between businesses and across industry and academia. This was achieved through requiring collaboration as a condition of funding in the CR&D and Accelerator models and investing in networks (InterAct and the MSI Network) to support wider collaboration among programme beneficiaries and across the sector.
- The progression from low TRL research through to commercialisation and adoption may take a number of years, even longer than the five years of the MSI Challenge. Thus a set of workstreams woven into a single programme can only be effective at scale if it has the longevity to support multiple companies through the innovation process. The 'package' of support from MSI was broadly welcomed (i.e. instead of individual initiatives) but greater impact could be achieved if the Challenge was allowed to run for a longer period.

SQW

Contact

For more information:

Osman Anwar
Director, SQW
T: +44(0) 7834 885084
E: oanwar@sqw.co.uk

9 Coates Crescent
Edinburgh
EH3 7AL

www.sqw.co.uk

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