FINAL EVALUATION OF THE FUTURE FLIGHT CHALLENGE

Final report

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Contents

LIST OF ACRONYMS AND ABBREVIATIONS

AABS	Atypical Airspace BVLOS Solution
AAM	Advanced air mobility
ABS	Annual Business Survey
AI	Artificial intelligence
BEIS	Business, Energy and Industry Strategy
BSD	Business Structure Database
BSI	British Standards Institution
BVLOS	Beyond visual line of sight
CAA	Civil Aviation Authority
CPC	Connected Places Catapult
CPD	Continuing professional development
DfT	Department for Transport
DIAG	Drones Industry Action Group
EASA	European Union Aviation Safety Agency
ESRC	Economic and Social Research Council
eVTOL	Electrical vertical take-off and landing
FAA	Federal Aviation Administration
FAIWG:AI	Future Aviation Industry Working Group on Airspace Integration
FFC	Future Flight Challenge
FFIG	Future of Flight Industry Group
GVA	Gross value added
IET	Institute of Engineering Technology
IP	Intellectual property
ISCF	Industrial Strategy Challenge Fund

JARUS	Joint Authorities for Rulemaking on Unmanned Systems
NATS	National Air Traffic Services
ODD	Operational Design Domain
ONS	Office for National Statistics
PAYE	Pay as you earn
R&D	Research and development
RPAS	Remotely operated aircraft systems
SIC	Standard Industrial Classifications
SME	Small and medium-sized enterprises
STEM	Science, technology, engineering and mathematics
TRL	Technology readiness level
UAM	Unarmed air mobility
UAS	Unmanned aerial systems
UAV	Unmanned aerial vehicle
UKBC	UK Business Connect
UKRI	UK Research and Innovation
UK SORA	UK Specific Operations Risk Assessment
VAT	Value-added tax

EXECUTIVE SUMMARY[1]

The Future Flight Challenge

The **Future Flight Challenge (FFC)** defines the future flight sector as organisations engaged in developing, commercialising, producing, and supporting technologies or services related to **unmanned aerial systems (UAS), advanced air mobility (AAM),** and **regional electric conventional aircraft**. It also includes the necessary digital and physical infrastructure, integrated systems, and regulatory frameworks for its coherent development and operation.

The UK has the potential to lead internationally in this sector but faces key challenges such as infrastructure limitations, regulatory and air traffic management barriers, underinvestment in research and development (R&D), and environmental concerns. The FFC was established to address these issues and strengthen the UK's global position.

Launched in 2019, the FFC is a £300 million investment programme, which comprises £125 million committed by the public sector under the Industrial Strategy Challenge Fund (ISCF) and £175 million in industry co-investment. It provides grants to industry consortia developing aviation technologies to address mobility, congestion, and carbon reduction, particularly in densely populated or ageing communities. The FFC also supports regulatory development, knowledge exchange, and strategic policy input for the government.

The FFC has been structured into three phases running from 2019 to 2025. The **Discovery Phase** (2019-2020) identified key challenges and opportunities within the future flight sector. The **Development Phase** (2021-2022) provided funding and support for early-stage innovations. The **Demonstration Phase** (2022-2025) is focused on large-scale deployment and validation of solutions. This phased approach was designed to ensure effective collaboration within consortia. It also allowed the FFC to adapt later funding competitions in response to technological advancements and lessons learnt while mitigating risks associated with allocating large grants to projects that may not reach successful deployment.

Evaluation approach

As part of the evaluation framework, we developed a **theory of change** in collaboration with the FFC to outline how its inputs and activities would generate outputs, outcomes, and impacts. This was translated into 11 evaluation themes structuring the impact evaluation of the Challenge.

These themes were grouped into three categories: **shorter-term outcomes** (measurable by 2022), **medium- and long-term effects** (anticipated to be measurable from 2024 onwards),

[1] We would like to thank the Office for National Statistics (ONS) Secure Research Service for facilitating access to the secondary statistical data used to produce this report. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

and **longer-term impacts** (likely emerging post Challenge). A 2023 interim evaluation analysed shorter-term outcomes and included a process evaluation. This report builds on those findings, tracking their evolution and offering insights into emerging medium- and long-term effects. The shorter-term outcomes were analysed in 2023 as part of an interim impact evaluation of the Challenge, which also provided a process evaluation. This report builds on those findings by examining how shorter-term outcomes have evolved while also providing emerging insights into the medium-, long-, and longer-term effects.

Given the complexity of the FFC's operating environment and its wide-ranging impacts, we applied a **theory-based approach** using **contribution analysis** to assess its added value beyond what would have occurred without it (counterfactual). A **mixed-methods approach** was used, drawing on five key evidence sources: (1) an industry survey of future flight sector organisations (181 responses), (2) five case studies based on 18 in-depth interviews with stakeholders, (3) FFC monitoring data, (4) other secondary sources, and (5) a rapid literature review. Throughout the report, results from the baseline, interim impact, and final impact surveys are compared where possible to observe trends over time.

Key messages from the evaluation themes

The FFC has laid the groundwork for a transformative aviation sector in the UK. In particular, the evaluation findings highlight the FFC's crucial role in advancing the UK's future flight sector through three main mechanisms in line with its theory of change: (1) driving technological progress, (2) fostering collaboration, and (3) attracting both public and private investment. However, ongoing challenges beyond the Challenge's current scope need to be addressed to sustain progress and gain competitive advantages in the global future flight market. Below we provide more detail and some of the key supporting evidence for each evaluation theme.

Theme 1 - Has the technological readiness of future flight technologies been progressed as a result of FFC?

Case study evidence shows that **the Challenge has significantly enhanced technological readiness**, particularly for high and medium technology readiness level (TRL) projects such as UAS and electrical vertical take-off and landings (eVTOLs), accelerating their path toward commercial viability. However, progress has been slower for hybrid-electric/hydrogen aircraft and supporting digital and physical infrastructure.

Survey findings indicate that **Demonstration Phase consortia have increased technological readiness**, with 71% reporting a TRL increase. Projects at TRL 1 or 2 dropped from 21% to 3%, while those at TRL 7 or higher rose from 6% to 29%. Despite this progress, industry stakeholders remain concerned about regulatory barriers and financial sustainability.

Demonstrations have showcased the potential for low-emission solutions and operational efficiencies but have also highlighted costs, risks, and regulatory hurdles. Stakeholders interviewed noted that while **FFC-enabled demonstrations had clarified deployment**

barriers and "unseen" risks, they were **often limited in scale and lacked integration** with broader aerospace operations and users.

Regulation was frequently cited by stakeholders as a major constraint. The proportion of respondents who rated the Civil Aviation Authority (CAA) demonstration approval process as "extremely inefficient" rose significantly from 9% in the interim evaluation to 23% in the final survey. Many stakeholders highlighted restrictive testing environments as a barrier to meaningful trials. Stakeholders, particularly larger firms, noted that slow regulatory development created investment uncertainty, hindering commercial deployment planning.

Financial barriers remain a significant challenge, particularly for small and medium-sized enterprises (SMEs), which have struggled with the high costs associated with regulatory compliance and large-scale demonstrations. Some SMEs suggested a **phased approach to demonstrations** with a limited number of well-defined use cases to reduce risks, improve public acceptance, and ease the path to in-service operations.

Additionally, concerns were raised about **limited data sharing across the industry**, with some stakeholders arguing that **greater transparency in demonstration findings** could help accelerate sector-wide learning and reduce duplicated efforts.

Theme 2 - Has the FFC increased collaboration within the future flight sector, and between the sector and other stakeholders?

A key achievement of the FFC has been **fostering collaboration** among SMEs, large firms, regulators, government bodies, and international stakeholders, creating a **more unified future flight community**. Survey and case study evidence confirm that **the FFC has enabled collaboration on an unprecedented scale and complexity**. Industry stakeholders widely viewed the Challenge as a "gamechanger", accelerating joint delivery of future flight technologies that would otherwise have been developed in isolated workstreams, at a slower pace, or not at all.

The evaluation found that 81% of survey respondents reported increased collaboration due to the Challenge, with 41% stating the impact was significant. This engagement remained steady across the evaluation phases, highlighting the **Challenge's early and sustained success in building a cohesive innovation ecosystem**. **Interdisciplinary partnerships have strengthened over time**, with the proportion of respondents who strongly agreed that the Challenge had encouraged cross-discipline collaboration increasing from 34% to 48% between the interim and final evaluation. Industry interviews suggest these relationships will extend into future funding opportunities and long-term partnerships.

Beyond FFC-funded consortia, **collaboration has expanded across the wider industry**. Over half of survey respondents (52%) reported working with more than five organisations outside their consortia, demonstrating a wider network effect driven by the Challenge. The most frequent partnerships involved non-aviation SMEs (75%), regulators (74%), and researchers (69%), illustrating the diversity of stakeholders engaged in shaping the sector's

future. The number of collaborations per respondent increased across most categories between the interim and final evaluations, indicating sustained engagement catalysed by the FFC.

The FFC has also **enhanced international engagement**, providing UK organisations with platforms to showcase innovations on a global stage. Survey data shows that the percentage of respondents collaborating with five or more international companies rose from 10% in the interim evaluation to 21% in the final survey. Events like DroneX and the Farnborough International Airshow (FIA) helped UK organisations to showcase innovations to overseas partners and investors. However, some international stakeholders cited UK regulatory complexities and limited financial incentives as challenges compared to other jurisdictions.

Knowledge sharing has further boosted collaboration, with 76% of respondents finding FFC publications "very useful" or "useful". UK Business Connect (UKBC) monitoring data showed engagement spikes whenever key reports and roadmaps were published, reinforcing the Challenge's influence on industry strategy beyond funding.

Theme 3 - Has the CAA developed a set of robust regulatory frameworks to support the future flight sector?

Evidence from the case studies shows that the Challenge has played a key role in **shaping the UK's regulatory landscape for future flight technologies,** particularly for beyond visual line of sight (BVLOS) operations. It has provided critical funding to the CAA, fostered engagement between industry and the regulator, and enabled controlled technology demonstrations that have informed policy development.

However, **regulatory progress remains a major bottleneck**, with stakeholders expressing concerns about the pace of regulatory development lagging behind technological advancements. While regulatory frameworks have evolved in the past two years, complex approvals and unclear guidelines continue to delay full-scale commercial deployment. Stakeholders cited capacity constraints at the CAA, exacerbated by Brexit, as a major challenge that continues to affect its regulatory responsiveness. This has raised concerns about the UK's ability to remain internationally competitive in regulatory innovation.

Industry representatives acknowledged that **collaboration through working groups like the Future Aviation Industry Working Group on Airspace Integration (FAIWG:AI) has improved regulatory clarity**, and the "Future Flight Action Plan" (published in 2024 with the participation of the Challenge) now sets milestones for the CAA to move towards the integration of future flight technologies into UK airspace. The **usefulness of CAA publications in supporting organisations through regulatory compliance has also improved**. Survey findings show that 64% of final survey respondents found guidance helpful and 71% of consortia members credited the FFC for enhancing regulatory communication.

Despite these improvements, **regulatory uncertainty threatens the UK's competitiveness in the sector**. The percentage of respondents who viewed regulation as an enabler fell from

50% to 38%, while those who saw it as a barrier rose to 51%. This is particularly concerning given that international comparisons suggest the UK is losing its early leadership position. In the baseline survey, 40% of respondents believed the UK was ahead of most countries in future flight regulation, but this dropped to 24% in the final evaluation, with 41% then stating that the UK lagged behind.

A major challenge remains the **lack of standardised frameworks for emerging technologies** like detect-and-avoid systems, electronic conspicuity, and unmanned traffic management. With UK Specific Operations Risk Assessment (SORA) set to replace the Operating Safety Case by 2025, businesses, especially SMEs, are particularly concerned about high compliance costs and regulatory complexity. Divergence from European Union Aviation Safety Agency and Federal Aviation Administration standards risks adding administrative burdens, limiting international operations, and driving businesses to relocate to more flexible regulatory environments.

Theme 4 - Has the FFC increased investment and R&D in future flight technologies?

The Challenge has also **successfully catalysed investment**. **It has leveraged £217 million in industry co-investment, surpassing its initial target by 24%**. In addition, nearly half of survey respondents reported an **increase in R&D spending due to their engagement with the FFC**, with 89% stating this represented new funding.

Analysis of investment trends using Crunchbase data suggests that **businesses supported by the Challenge have been more successful in attracting private capital** than those outside the programme. Similarly, data from the Gateway to Research portal shows a **sixfold increase in public sector investment for future flight R&D studies** between 2019 and 2023, reflecting a strong commitment to the sector.

In addition, the **FFC has significantly improved access to investment**. Survey data shows that 45% of respondents secured additional funding due to the Challenge, up from 18% at baseline, and 51% expected further investment. However, stakeholders stressed that achieving in-service operations and demonstrating the commercial viability of future flight technologies would be essential to sustain investment interest.

Despite these gains, **confidence in private sector investment has declined**. The proportion of respondents who viewed investment as a barrier rose from 15% to 32%, and those who believed that the UK was falling behind in attracting capital increased from 24% to 45%. Stakeholders cited economic uncertainty, post-Brexit challenges, and stronger incentives in competing markets as key concerns, raising doubts about the UK's ability to retain capital beyond the FFC. **SMEs are particularly vulnerable**, with some fearing their operations may become unsustainable without continued support.

Theme 5 - Has the FFC helped to shape a coherent government policy that supports the development and operation of future flight technologies in the UK?

The FFC has been instrumental in shaping UK government policy for future flight technologies, contributing to key strategies such as "Flightpath to the Future" (2022) and the "Future Flight Action Plan" (2024). It has also supported broader policy discussions through initiatives such as the FAIWG:AI, the Aviation Council, and the Drones Industry Action Group. As a result, the majority of survey respondents (84%) recognised the FFC's positive impact on government policy, with only 4% stating otherwise.

Despite this influence, **government policy is increasingly viewed as a barrier to industry progress**. While 54% of respondents still considered policy as an enabler, this figure remained unchanged since the interim survey, and confidence in its effectiveness was declining. The proportion of those who saw policy as a "significant enabler" dropped from 32% at baseline to just 13% in the final evaluation, while 35% now perceive it as a barrier.

Concerns about the UK's global positioning in future flight policy have also intensified. The proportion of respondents who believed the UK was a world leader or ahead of most countries in government policy fell to 19%, down from 33% at baseline. Meanwhile, those who felt the UK lagged behind increased to 34%, reflecting persistent challenges in aligning national policy with industry needs.

While the UK has the potential to lead in UAS and AAM, **stakeholders stressed the need for a clear, cross-government strategy**. Many industry stakeholders interviewed were unaware of key policy documents, underscoring the need for better communication and integration. Interviewees indicated that, without a coordinated approach aligning regulatory and investment frameworks with industry needs, the UK risks falling behind international competitors in developing a globally competitive future flight sector.

Theme 6 - Has the FFC helped to improve public attitudes to future flight technologies?

Public perceptions of future flight technologies remain mixed, with strong support for certain use cases like emergency services and rural connectivity, but ongoing concerns about safety, privacy, and environmental impact. The Challenge has worked to **improve awareness and address public concerns**, and 66% of survey respondents acknowledged its positive impact. However, 31% believed that the UK lags behind other countries in public attitudes, a perception that has persisted since the interim evaluation.

Survey findings indicate a **divided outlook on public perceptions as either a barrier to or an enabler of sector progress**. In the final evaluation, 40% of respondents saw public perceptions as an enabler, while 39% viewed them as a barrier, highlighting a lack of broad public confidence in these technologies. Awareness levels also vary significantly; while 95% of the public are familiar with drones, only 28% have heard of eVTOLs and 24% of regional air mobility technologies.

Key **concerns include cybersecurity, safety risks, and scepticism about environmental benefits**. Qualitative research highlights worries over **noise, accessibility, and affordability**, emphasising the need for inclusivity and sustainability of future flight technologies. Demonstrating practical, near-term applications (rather than futuristic concepts like flying taxis) is seen by stakeholders as essential for building trust.

Despite these challenges, **some FFC-backed projects have improved perceptions**. Project CAELUS increased awareness of UAS for medical deliveries, while Project XCelerate found that 68% of the public now view UAS positively, particularly for emergency response and rural connectivity.

Theme 7 - Has the FFC helped to build the skills needed to support future flight technologies?

While 51% of respondents saw workforce skills as an enabler, **concerns over skill shortages have grown over time**, with 38% now viewing skills as a barrier, more than double the 18% at baseline. However, stakeholders interviewed as part of the case studies did not cite this as a major obstacle.

FFC monitoring data shows that **supported projects have helped skill development**, with all 25 organisations that had completed their close-out forms for their Demonstration projects indicating they had gained at least one new skill in technical and strategic areas.

Theme 8 - Has the FFC accelerated the formation of economic clusters developing and producing future flight technologies in the UK?

There is evidence that the **FFC has contributed to driving economic growth within the UK's future flight sector**. In particular, FFC's successful participants are experiencing growth and scaling, with an increasing number of micro and small organisations entering the future flight market since the baseline. In addition, 48% of supported organisations reported a positive impact of the FFC on their turnover, with an average increase of 24%, while 46% saw employment gains due to their engagement with the Challenge. The **programme's £100 million investment is estimated to have generated an additional £772 million in additional future flight turnover**, highlighting a significant return on investment, although there are limitations in this calculation.

The **economic benefits of the FFC are particularly pronounced among SMEs**, which is consistent with the fact that approximately 70% of successful projects were led by SMEs. Unlike larger organisations, which often have diversified revenue streams, SMEs tend to rely more heavily on future flight activities, leading to more immediate and tangible benefits from FFC funding.

It is important to mention that the commercialisation of future flight technologies remains in its early stages, and the **full economic impact of the Challenge is expected to materialise over the coming years**.

Theme 9 - Has the FFC helped to encourage a diverse future flight sector?

The Challenge has c**ontributed to fostering diversity and inclusivity within the sector by supporting businesses of varying sizes, industries, and regions.** Distribution of businesses supported by the Challenge indicates that, while micro and small businesses dominate this group, larger firms have been over-represented among FFC successful participants compared to the UK average. Encouragingly, there is evidence of growth and scaling, with the proportion of medium-sized businesses increasing from 9% to 13% between the baseline and the final evaluation.

The **sector's multidisciplinary nature** is reflected in the diversity of FFC successful participants, spanning aerospace, software, IT consultancy, research, and professional services. This broad participation highlights the **sector's reliance on a diverse set of technical and managerial expertise, which is essential for its continued innovation and growth**.

However, **regional distribution of FFC successful participants is uneven**, with 28% of successful businesses headquartered in London, 20% in the South East, and 15% in the South West, while businesses in the devolved nations remain under-represented. These figures align with the general business distribution across the UK, although they also indicate **potential geographic disparities in sector support and access to funding**.

There have also been **positive developments in workforce diversity**, particularly in gender representation within R&D roles. The proportion of FFC-supported organisations with no female or non-binary employees in R&D dropped from 34% in the interim evaluation to 23% in the final survey, indicating most improvements. Furthermore, FFC participants generally reported higher levels of gender diversity in comparison to non-participating UKBC organisations, where 43% had no female or non-binary R&D staff. While these trends are encouraging, **significant diversity gaps remain**, underlining the need for continued efforts to attract and retain under-represented groups within the sector.

Theme 10 - Has the FFC accelerated the deployment of future flight technologies in the UK, leading to economic and social benefits?

The Challenge has been recognised as a "technology enabler", advancing collaboration, regulation, and infrastructure. However, some stakeholders interviewed felt it focused more on enabling technologies than directly driving net zero outcomes, suggesting that further policy support may be needed. Therefore, it is too soon to assess the contribution of the Challenge towards achieving the UK's net zero targets.

Nevertheless, the **Challenge** has showcased the potential of some future flight technologies in supporting the transition from carbon-intensive vehicles to zero-emission solutions. For example, demonstrations of drone-based medical supply deliveries in Scotland, and parcel transport in the Orkney Islands have highlighted how these technologies could replace conventional transport, reducing emissions and increasing operational efficiency. While the

FFC has raised industry awareness of emissions reductions, stakeholders noted that **full lifecycle environmental impacts remain unclear**, requiring further assessment.

The **rapid literature review found that future flight technologies have the potential to offer benefits,** such as reduced carbon emissions, improved operational efficiency, and safety gains, but also might present costs related to battery production, electricity grid emissions, infrastructure requirements, and potential social impacts like noise pollution and equity concerns.

Theme 11 - Has the FFC increased the contribution of aviation and aerospace sectors to the UK economy?

While it is too early to assess the full long-term impact of the FFC, early indicators suggest that the **Challenge has helped stabilise employment, support scaling, and mitigate turnover declines for successful firms**. The sector's strength lies in its broad ecosystem, encompassing consultancy, software development, technology services, and manufacturing, rather than being confined to traditional aviation activities.

Since 2019, industry consolidation has led to fewer small firms but more medium-sized businesses, indicating scaling and maturity. Between 2019 and 2023, the sector shrunk by 3% annually, mainly due to micro and small firm reductions, although medium-sized businesses grew by 4%. Employment has remained stable, with 1.7 million people employed in industries similar to those of FFC applicants, including 160,000 in traditional aviation and aerospace activities. In contrast, non-FFC firms saw a 2% decline in employment, suggesting the Challenge's potential positive impact on supported businesses.

Sector turnover reached £302 billion in 2023, with £35 billion from traditional aviation and aerospace and the rest from industries similar to those of FFC applicants. However, overall turnover has declined since 2019, largely due to the loss of small firms. Medium-sized businesses saw 2% growth, reinforcing the scaling trend. Notably, companies that did not engage with the FFC saw a 12% decline in turnover, while FFC-supported firms experienced a less severe decrease of 4%, indicating the resilience of Challenge participants. **Companies operating within industries similar to those of FFC applicants significantly contribute to the UK economy, representing approximately 4.8% of total private sector turnover**, comparable to established industries like construction and information technology.

Gross value added (GVA) grew by 6% from £246 billion (2019) to £288 billion (2022), largely driven by economic activities such as business support, consultancy, and programming, which now account for nearly half of the sector's GVA. **Companies operating within industries similar to those of FFC applicants contributed up to 13.4% of the UK's GVA**, a share comparable to the production sector (14.3%). In contrast, the traditional aviation sector accounted for just 2% of the UK's GVA.

Recommendations and lessons learnt

Based on case study insights, key lessons have been identified to address these challenges. Stakeholders stressed the **need for more frequent, large-scale, real-world demonstrations** to support regulatory advancements and better integrate future flight technologies into existing airspace. More **focused investment in high-impact areas** could accelerate progress toward operational and commercial readiness. **Regulatory clarity and flexibility** is also essential, with stakeholders calling for frameworks that evolve alongside technological advancements and include interim measures such as dedicated air corridors for BVLOS operations or exception mechanisms for testing. Additionally, **increased uptake of electronic conspicuity** devices, greater data sharing, and clearer pathways for commercialisation are necessary to ensure sector-wide growth.

To build on these lessons, stakeholders proposed several actionable recommendations. **Maintaining collaboration networks** and preserving expertise gained through the Challenge are critical for sustaining momentum. A **clear government-led vision and strategic roadmap towards the commercialisation and industrialisation** of future flight technologies are needed to provide direction for the sector and attract further investment. **Continued financial support** is also crucial, particularly for SMEs facing funding gaps. Finally, **investment in critical infrastructure**, including vertiports, charging stations, and improved airspace management, will be essential in enabling the next phase of growth in the UK's future flight sector.

1 Context: The Future Flight Challenge

1.1 The rationale

The future flight sector is a small but fast-growing part of the UK economy. It encompasses organisations engaged in developing, commercialising, producing, and supporting the deployment of technologies or services related to unmanned aerial systems (UAS), advanced air mobility (AAM), and regional electric conventional aircraft. The sector also includes the digital and physical infrastructure, integrated systems, and regulatory frameworks necessary for its coherent development and operation.

There is significant investment in research and development (R&D) within the future flight sector, both in the UK and globally. With established competitive advantages in regulation, design engineering, and digital and physical infrastructure, the UK is well positioned to become a global market leader in this rapidly growing sector.

However, various market failures and institutional barriers could hinder this potential. These include underinvestment in R&D by the private sector, regulatory and air traffic management barriers, coordination challenges, and infrastructure limitations. The Future Flight Challenge (FFC) was designed to address these market failures.

1.2 The structure and objectives

The FFC is a £300 million investment programme launched in 2019, which comprises £125 million committed by the public sector under the Industrial Strategy Challenge Fund (ISCF) and £175 million co-invested by industry. The Challenge supports the development of technologies aimed at addressing mobility and congestion challenges faced by an increasingly urban and ageing population, while also reducing the global aviation sector's carbon footprint. The FFC provides grants to industry consortia tackling these challenges and facilitates supporting activities, including knowledge exchange, development of regulatory frameworks, strategic policy input for government, and the production of reports.

The FFC business case outlined four key objectives: (1) increasing business investment and R&D; (2) safeguarding the UK's aerospace advantage; (3) delivering a reduction in aviation emissions; and (4) realising economic benefits through improved mobility.

The Challenge is structured into three interconnected phases: the Discovery Phase (2019-2020), the Development Phase (2020-2022), and the Demonstration Phase (2022-2025). The Challenge is expected to conclude in March 2025.

1.3 Theory of change

The theory of change outlines how the FFC expected to transform inputs and activities into outputs, outcomes, and impacts. Developed collaboratively with the FFC as part of the wider

evaluation framework, the theory provides context and rationale for the evaluation themes and metrics used to structure this report.[2]

The FFC draws on five categories of **inputs**: funding from UK Research and Innovation (UKRI) and industry; staff time from the FFC, supporting agencies, and industry; strategic plans and roadmaps from the transport sector and broader ISCF initiatives; FFC business cases, plans, and institutional arrangements; and the existing R&D capacity, skills, and supply chain within the UK.

Collectively, these inputs generate five categories of **outputs** and **activities**: three phases of competitions to award funding; knowledge exchange activities facilitated by UK Business Connect (UKBC) (previously known as the Knowledge Transfer Network); development of a regulatory framework supported by the Civil Aviation Authority (CAA); development of standards supported by the British Standards Institution (BSI); strategic input into government policymaking; and various reports, frameworks, and supporting social sciences research.

The outputs drive four **immediate outcomes**: increased readiness of future flight technologies; enhanced collaboration within and across relevant sectors; adoption of a new regulatory framework; and increased investment and R&D in the sector. These immediate outcomes align with the five high-level objectives of the ISCF: increased UK business investment in R&D (ISCF1); improved interdisciplinary research (ISCF2); enhanced business-academic innovation engagement (ISCF3); greater collaboration between smaller, younger companies and established ones (ISCF4); and increased overseas investment in UK R&D (ISCF5). Additionally, FFC activities and outputs influence key **enablers** beyond the Challenge, including coherent government policies, supporting infrastructure, skills and supply chains, social acceptance, and demand for future flight technologies.[3]

These outcomes and enablers are essential for establishing a competitive UK future flight sector, the programme's primary **intermediate outcome**. They also facilitate the deployment of future flight technologies tailored to UK-specific requirements. The **ultimate impact** of the Challenge is to safeguard the UK's competitive advantage in aviation and aerospace, increasing their contribution to the economy. Furthermore, deploying these technologies in the UK will also generate **spillovers**, delivering economic and social benefits through improved mobility and reduced transport emissions.

The theory of change is visualised in the logic model presented in Figure 1.

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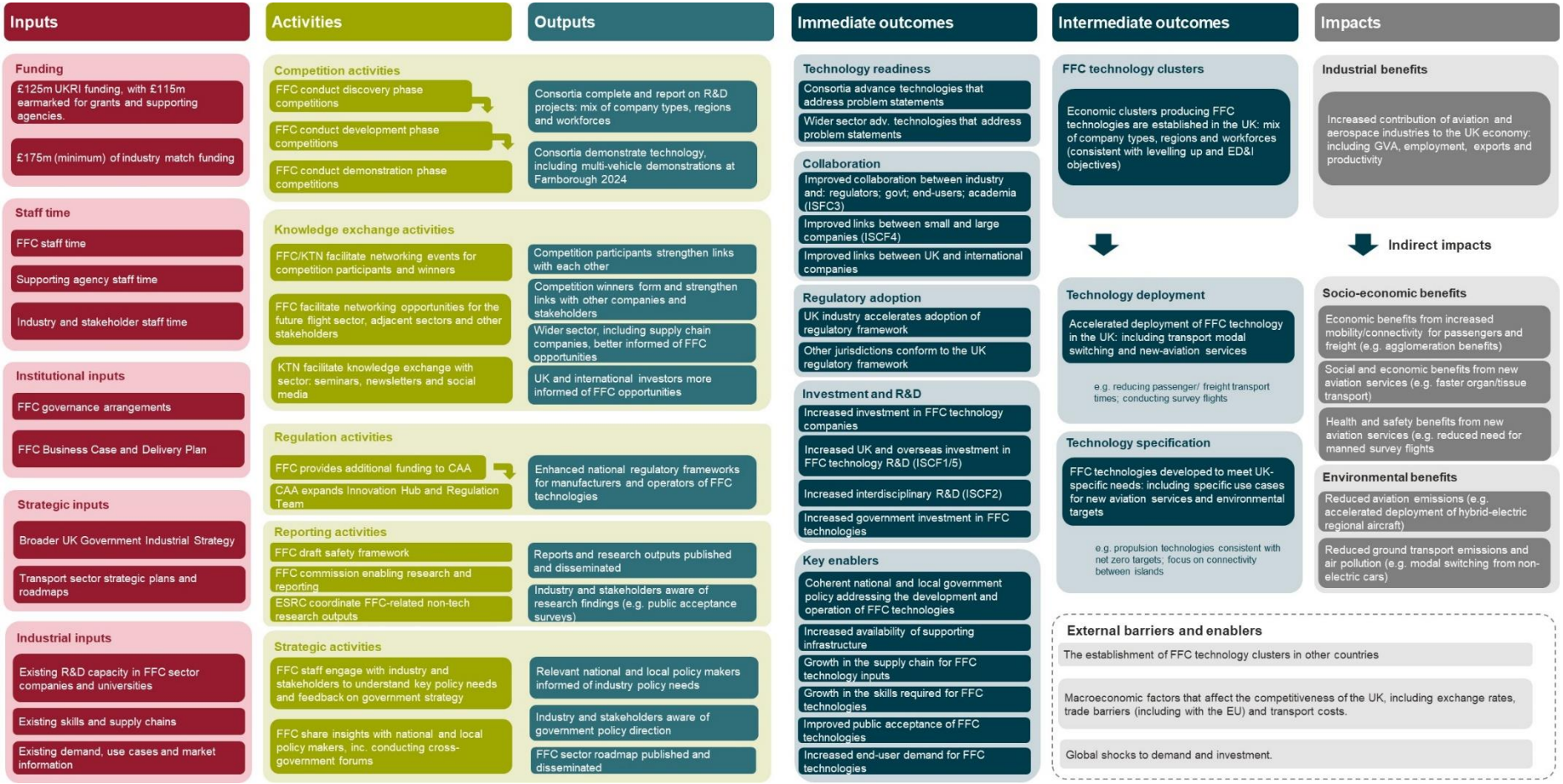
2 The evaluation framework was completed in 2021 as a collaborative exercise between the evaluation consortium (Frontier Economics, Frazer-Nash Consultancy, and BMG Research), the FFC and Innovate UK. The framework was refreshed in the light of insights from the interim evaluation at the start of 2024, although this refresh did not alter the theory of change in any meaningful way.

3 Other enablers that are outside the control of the FFC include: the progress of competitors in the future flight market; related UK government interventions; and the effects of Brexit and other shocks to demand and investment.

Figure 1 Future Flight Challenge Logic Model



Source: *Frontier Economics*

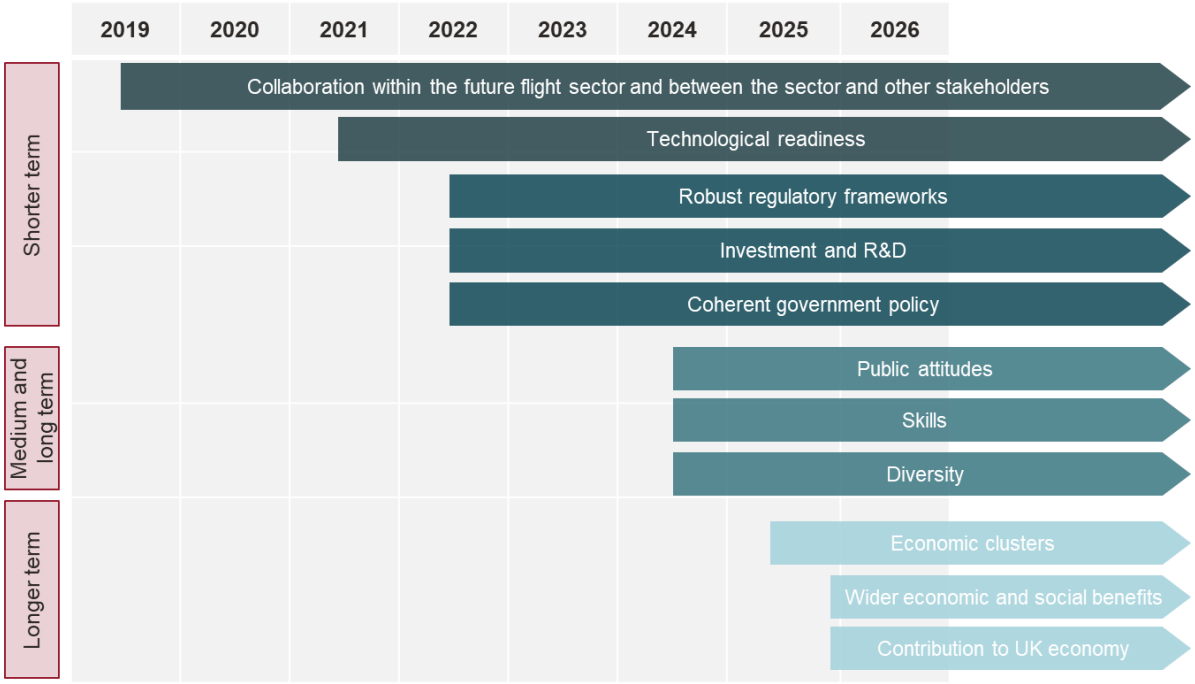
Note: *ISCF numbers refer to the five ISCF high-level objectives.*

2 Final impact evaluation approach

The evaluation framework translated the theory of change presented in Section 1 into 11 evaluation themes that structure the impact evaluation of the FFC. These themes are divided into three groups: shorter-term outcomes, which were expected to have material and measurable outcomes by 2022; medium- and long-term effects, where the impact of the FFC is expected to be measurable from 2024 onwards; and longer-term outcomes and impacts, where the full benefits are likely only to emerge after the Challenge has concluded.

The shorter-term outcomes were analysed in an interim impact evaluation of the Challenge, which also provided a process evaluation.[4] This report examines how the shorter-term outcomes have evolved since the interim evaluation and provides emerging findings on the medium-, long- and longer-term effects.

Figure 2 Evaluation themes and expected timeline of FFC emerging effects



Source: Frontier Economics

The evaluation themes were developed and refined collaboratively with FFC stakeholders and were designed to align with the theory of change, encompassing the activities, outputs, outcomes, and impacts identified. Additionally, as the organisations supported by the Challenge have evolved, they are now considering the next steps toward in-service operations. Therefore, this evaluation also presents early findings about how the Challenge

[4] UKRI (2023) Future Flight Challenge: interim and process evaluation

has helped prepare the sector for the industrialisation and commercialisation of future flight technologies, an area that extends beyond the scope of the theory of change outlined above.

As identified in the underlying evaluation framework, the complexity of the landscape in which the FFC operates and the range of thematic impact areas imply the use of a **theory-based evaluation**. Specifically, we deploy **contribution analysis** in which, for each theme, the evaluation aims to assess the contribution of the FFC in delivering benefits over and above what would have occurred without the Challenge (the counterfactual).

To support this, we deploy a **mixed-methods** approach in which a range of evidence sources (see below) are assessed for metrics relating to each evaluation theme. We **triangulate** evidence of how these metrics have evolved since the Challenge began (comparing a baseline position with more recent evidence) and evidence on the extent to which the Challenge or other factors have influenced observed changes to draw inference. This evidence comprises both quantitative and qualitative data, self-reported evidence on the contribution of the Challenge from surveys and interviews, survey-based evidence from some organisations which were not successful in their bid for support from the Challenge as a source of counterfactual insight, and trend-based analysis of internal monitoring and secondary data.

Importantly, as with the interim evaluation, the final impact evaluation report presents preliminary findings. Many of the medium- and long-term effects of the FFC on the future flight sector and the UK economy will take time to fully materialise. However, some of the metrics and data gathered as part of the final impact evaluation provide emerging insights into the perceived impact of the FFC to date.

2.1 Evidence sources for the final impact evaluation

Five key sources of evidence are used to inform this impact evaluation. These are: (1) an industry survey of future flight sector organisations, (2) case studies informed by interviews with future flight stakeholders, (3) FFC monitoring data, (4) secondary sources, and (5) rapid literature review.

2.1.1 Industry survey of future flight sector organisations

The survey aimed to assess the magnitude of the FFC's outputs and outcomes. The survey was conducted with industry and academic institutions that had engaged with the FFC, including those that successfully or unsuccessfully applied to FFC competitions, as well as some organisations that began their applications but did not complete them. Based on discussions with FFC stakeholders and expert input from Frazer-Nash Consultancy, this sampling frame is considered a good proxy for the types of organisations targeted by the FFC.

Additionally, organisations that had attended workshops and networking events organised by UK Business Connect (UKBC – previously known as the Knowledge Transfer Network), but that had not engaged directly with the FFC through any of its competitions, were also invited to participate. As this group was only included in this final evaluation, it is not possible to

assess how their responses evolved over time. Therefore, their responses provide a useful comparison with Challenge participants only at this point in time. Furthermore, their inclusion is intended solely to understand industry perceptions rather than to evaluate any spillover effects of the Challenge on their performance or to serve as a control group. While their insights help contextualise findings, they are not used to provide any evidence of the Challenge additionality or attribution.

The fieldwork took place between September and November 2024. An online survey link was sent out to contacts, followed by three email reminders to encourage participation. To maximise response rates, telephone follow-ups were conducted where contact numbers were available. A total of 181 respondents completed the survey (100 by telephone and 81 online), giving a response rate of 11%. This sample size is deemed to be robust for this evaluation as it is sufficiently large to ensure a high level of confidence in the results, corresponding to a 95% confidence level.

Throughout the report, results from the baseline, interim impact, and final impact surveys have been compared where possible to observe trends over time, with statistically significant differences between survey waves highlighted when appropriate. Table 1 below shows the response rates against the different types of engagement with the Challenge, and survey waves. Further details about the survey and characteristics of respondents are provided in Annex A. The overall number of respondents to the final evaluation survey was similar to those received in previous stages of the evaluation, although the overall response rate was slightly lower. The time elapsed between respondents' engagement with FFC competitions and their participation in the final survey is likely a key factor influencing response rates.

Table 1 Response rate by type of engagement with the Challenge

Survey wave	Final	Response rate	Interim	Response rate	Baseline	Response rate
All applications accepted	48	11%	57	13%	84	19%
A mix of accepted and rejected applications	25	22%	39	26%	17	25%
All applications rejected	54	11%	66	18%	48	24%
All applications not completed/submitted	18	7%	33	14%	5	3%
Not applicants (UKBC contacts)	36	n/a	2	50%	n/a	n/a
Total	**181**	**11%**	**197**	**17%**	**154**	**17%**

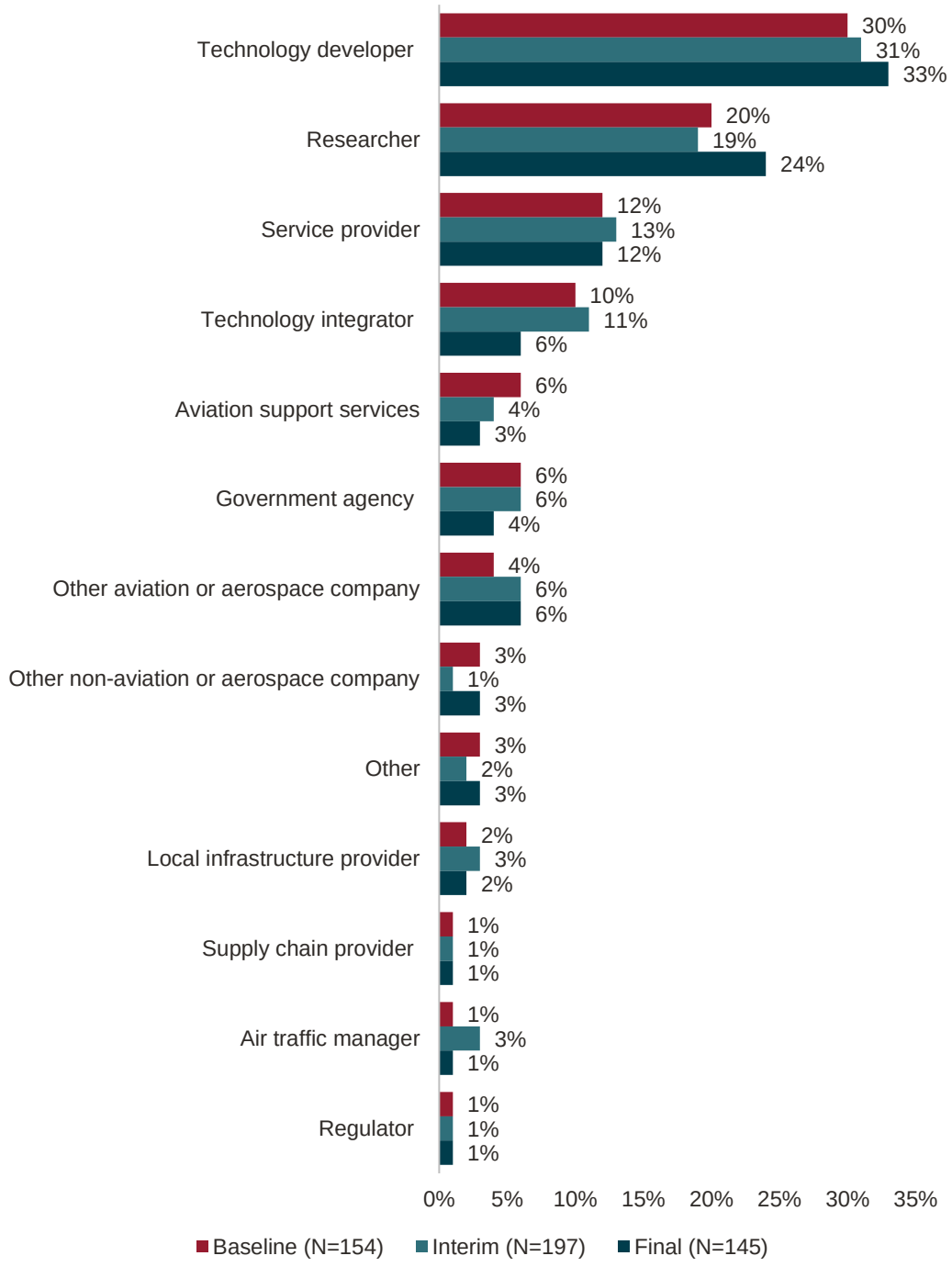
Source: Industry Survey

By comparing baseline, interim, and final survey results, we can observe trends in the sector across three points in time: 2020, 2022, and 2024. We highlight item responses that showed statistically significant differences between these surveys.[5] A statistically significant change indicates that the sample size was sufficient to detect a trend over time. However, the magnitude of the change is a critical indicator of its materiality (e.g., a small immaterial change could be statistically significant if the sample size is large). Therefore, our analysis and commentary focus on examining the magnitude of changes across survey items and between survey iterations.

In the survey, respondents were asked to choose the option from a predefined list that best described their organisation's relation to the future flight sector. Each respondent was allowed to select only one response. Figure 3 illustrates how the survey participants categorised their organisations. The distribution of organisation types was consistent between the final, interim, and baseline surveys, with no statistically significant differences identified. The largest group identified as technology developers (30%), followed by researchers (20%), service providers (12%), and technology integrators (10%). A similar distribution was found for UKBC contacts.

5 In this report. figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.

Figure 3 Involvement with the future flight sector



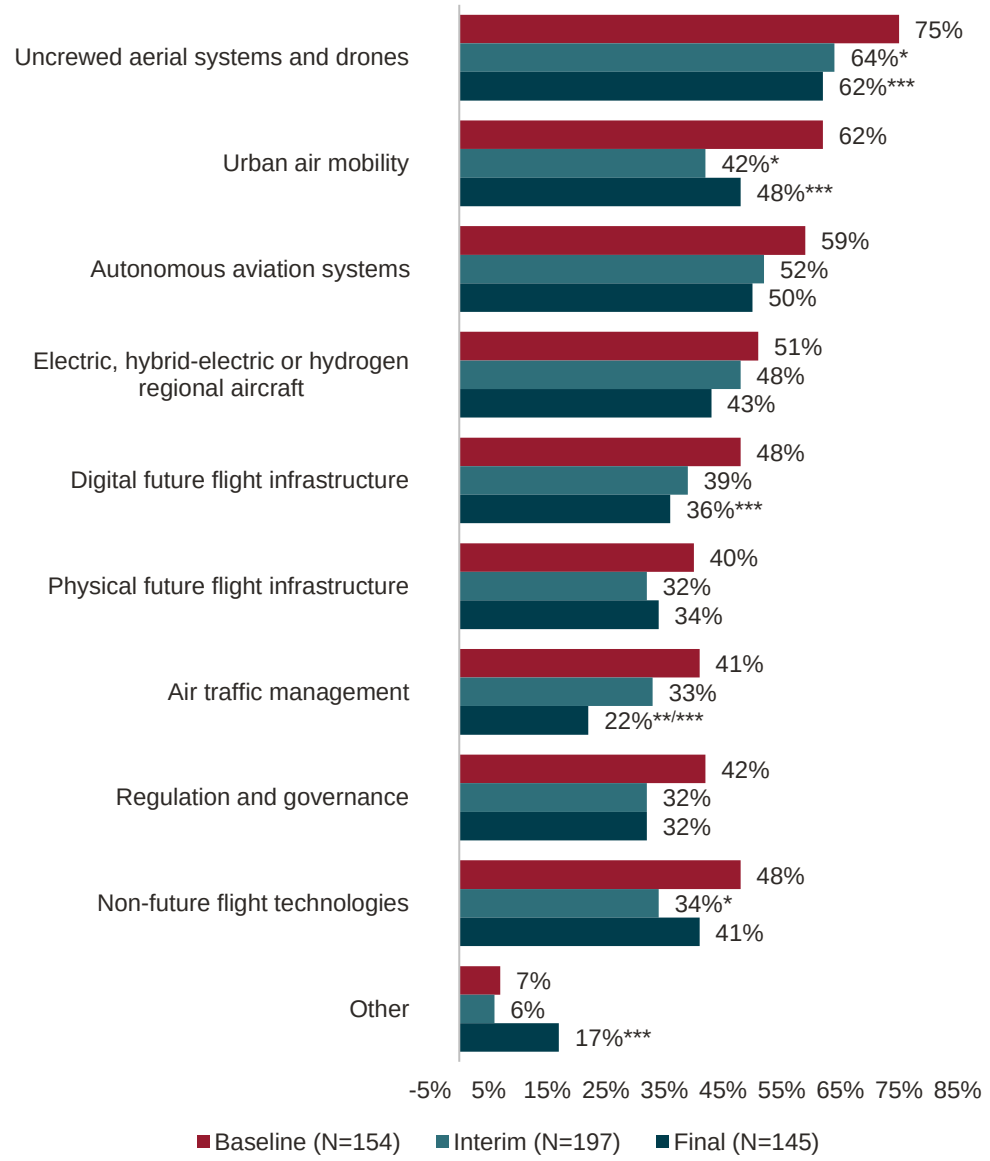
Source: *Industry Survey. A1. Which of the following best describes your organisation in relation to the future flight sector?*

Note: *Base: all respondents. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Figure 4 shows the areas of design and development in which respondent organisations and research groups specialised. The most common specialisms in the final survey were uncrewed aerial systems and drones (62%), autonomous aviation systems (50%), and urban air mobility (48%). Some differences in the composition of focus areas were observed in the final

evaluation survey compared to previous surveys. For example, compared to the baseline survey, respondents in the final evaluation were slightly less likely to report a focus on uncrewed aerial systems and drones, urban air mobility, digital infrastructure, or air traffic management. Conversely, they were significantly more likely to report "other" focus areas, which (based on open responses) included fields mainly related to non-future flight technologies, activities, and regulation. However, the interim and final evaluation samples showed greater similarity in reported focus areas. These differences should be considered when interpreting survey trends, as limited sample sizes generally make it difficult to analyse respondents by both focus area and survey wave.

Figure 4 Areas of focus of respondent organisations and research groups



Source: *Industry Survey. A3. Which of the following areas does your organisation or research group focus on in relation to the design and development of future flight technologies?*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Respondents were able to self-declare multiple areas of focus. Similar to the interim survey, the final survey revealed an upward trend in self-reported specialisation. Final survey respondents identified with an average of four specialisms, compared to five at the baseline. As noted in the interim evaluation, expert insights suggest that, as companies progress toward higher technology readiness levels (TRLs) and move into commercialisation, they tend to focus on narrower areas of specialisation.

Respondents who had submitted a competition application were also asked which phase of the FFC their organisation had participated in, whether successful or not, including those applications that had been started but not submitted. Among those who provided a response (120 respondents), two-thirds (66%) had been involved with the Development Phase, a similar proportion (63%) with the Demonstration Phase, and over half (56%) with the Discovery Phase. All respondents had participated in more than one phase. Researchers were more likely than average to have been involved in the Discovery Phase (77%), as were respondents engaged in regulation and governance (66%) and urban air mobility (66%).

2.1.2 Thematic case studies

The main objective of the case studies was to explore the FFC's role in addressing priority issues for UKRI stakeholders. While some case studies align with individual evaluation themes, others span multiple themes. Five thematic case studies were conducted on the following topics:

- Regulatory development
- Small and medium-sized enterprise (SME) development
- Role of large organisations
- Impact on net zero
- Commercialisation and industrialisation[6]

The focus of the thematic case studies was determined collaboratively by the evaluation team, FFC, and Innovate UK following a review of the evaluation approach in early 2024. This approach was designed to ensure that the case studies would yield useful and insightful evidence to assess the impact of the Challenge in key areas where other data was likely to be limited and to offer a valuable perspective on future developments.

These case studies were informed by 18 in-depth, semi-structured interviews with organisations of varying types, sizes, sub-sectors, and technologies, as detailed in Table 2. Interviews took place between August and October 2024, drawing on topic guides agreed with the FFC and tailored to the case study and interviewee. To ensure confidentiality and encourage open discussions, all interviewees were granted anonymity. As a result, any quotes included in this report are not attributed to any specific individuals.

[6] As this topic falls outside the scope of the FFC's theory of change, it is presented separately from the evaluation themes.

Table 2 Stakeholders interviewed

Organisation	Description of organisation
Civil Aviation Authority (CAA)	Statutory corporation which oversees and regulates all aspects of civil aviation in the UK, including unmanned aerial systems (UAS) and unarmed air mobility (UAM).
Federal Aviation Administration (FAA)	Federal government agency within the US Department of Transportation that regulates civil aviation in the US and surrounding international waters.
European Union Aviation Safety Agency (EASA)	Agency of the European Commission with responsibility for civil aviation safety in the European Union. It carries out certification, regulation, and standardisation and performs investigations and monitoring.
British Standards Institutions (BSI)	National standards body of the UK.
ADS Group	Trade organisation representing the aerospace, defence, security, and space industries in the UK.
Altitude Angel	Delivers solutions to enable the safe integration and use of drones and unmanned aerial vehicles (UAVs) into international airspace.
Heathrow Airport	UK's biggest airport, located in London.
National Air Traffic Services (NATS)	Provides air traffic services and innovative solutions to UK and international airports, airlines, and governments.
Cranfield Aerospace Solutions	Delivers zero emissions aircraft and propulsion technology.
Sees.ai	Develops operating system for the safe operation of UAV fleets at national scale.
Dronamics	Cargo drone airline that develops drone technology for cargo transportation and logistics operations.
Network Rail	Owner and infrastructure manager of most of the railway network in Great Britain.
Royal Mail	British postal service and courier company.
Skyports	Provider and operator of electrical vertical take-off and landing (eVTOL) drones for cargo delivery, survey and monitoring.

Organisation	Description of organisation
Urban-Air Port	Designs, develops, manufactures, sells, and operates ground, air, and digital infrastructure for new forms of sustainable urban air mobility.
National Grid	British multinational electricity and gas utility company.
GKN Aerospace	Supplier of automotive and aerospace components, including airframe and engine structures, landing gear, electrical interconnection systems, etc.
AGS Airports	Owner of Aberdeen, Glasgow, and Southampton airports.

Source: Frontier Economics

Evidence from case study interviews was combined with desk research to support a narrative account of each case. These narratives are structured into three main sections: (1) landscape overview, which describes the context before and after the Challenge; (2) Challenge contribution, which presents stakeholders' perspectives on how the Challenge has influenced observed changes; and (3) lessons learnt and future industry needs, which identifies industry needs beyond the Challenge.

2.1.3 Monitoring data

Internal FFC monitoring data, summarised in Table 3, provided high quality evidence on the characteristics of grant recipients and the activities and outputs undertaken to achieve the intended outcomes. This report incorporates key monitoring data collected by the Challenge between 2020 and 2024, when available, mapped into the relevant evaluation themes.

Table 3 FFC monitoring data sources used in the final evaluation

Data source	Description
Benefits Survey	The FFC collected benefits survey data from Development Phase consortia in three waves over 2021 and early 2022 and from Demonstration Phase consortia in one wave in early 2024.
Co-investment Survey	The FFC conducted co-investment surveys of Development Phase consortia in June 2022 and of Demonstration Phase consortia in February 2025.
Project close-out data	Project completion form completed by projects at the end of the engagement with the Challenge as part of Innovate UK monitoring processes.

Data source	Description
UK Business Connect (UKBC) web engagement metrics	UKBC activity records, as of July 2024.

Source: Frontier Economics

2.1.4 Secondary data

We also analysed additional secondary data collected by third parties which augments the evidence presented for a set of evaluation themes, in particular those related to public and private investment and contribution of aviation/aerospace sector to the UK economy. A high-level description of these data sources and a description of our analytical approach are summarised in Table 4 below. Further details can be found in the evaluation framework.

Table 4 Secondary data sources using the final evaluation

Data source	Description	Approach
Data compiled from R&D datasets	Gateway to Research – dataset with information on publicly funded research projects in the UK since April 2006	Algorithmic approach using "key words" to search R&D investments related to future flight sector.
Private investment data	Crunchbase – online platform that provides information on company profiles, funding rounds, investors and acquisitions, powered by proprietary private company data and web scraping	Trend analysis of private investment comparing successful companies, unsuccessful companies, and the rest of the future flight sector between 2014 and 2024.
Company-level microdata	Business Structure Database – extract from the Inter-Departmental Business Register, which covers VAT and PAYE registered firms (~96% of all firms in the UK)	Trend analysis of employment and turnover comparing successful companies, unsuccessful companies, and the rest of the future flight sector between 2014 and 2024. This involves using the unique Company Registration Number (CRN) to match FFC's monitoring data with the Business Structure Database.

Source: Frontier Economics

2.1.5 Rapid literature review

We also conducted a rapid literature review to gather evidence on the social and economic benefits and costs associated with future flight technologies, both for users and non-users. A rapid literature review is a streamlined approach to reviewing existing research, allowing for the efficient synthesis of key findings within a limited timeframe. This method was chosen because it is too early to assess the contribution of FFC-supported projects in this evaluation theme and evidence it is still limited.

3 Final evaluation findings

The findings are organised by evaluation theme. We adopt a common reporting structure for each theme which focuses on:

- **Key messages:** Highlighting the main findings from the final impact evaluation;
- **Aims and activities of the FFC:** Summarising the objectives it aimed to achieve and the activities undertaken, including any available monitoring evidence; and
- **Evaluation evidence:** Compiling survey data, monitoring data, case study findings, and secondary analysis on observed trends. For each evaluation theme, the extent to which these developments can be attributed to FFC activities is assessed, along with external factors affecting the achievement of the intended outcomes.

Before presenting thematic results, we begin with an overview of evidence on general barriers to and enablers of the development of the future flight sector which cut across multiple themes and provide wider context for the findings.

3.1 Barriers to and enablers of the development of the sector

The FFC interventions operate within a complex landscape, interacting with numerous other factors that influence sector outcomes. Survey respondents were asked to assess the extent to which they perceived various factors as barriers to or enablers of the development of the future flight sector. The baseline survey included ten potential factors, while the interim and final survey expanded the list to 14 factors (i.e., geopolitical instability, size of the future flight workforce, input costs, and local authority engagement) reflecting changes in external drivers relevant to the FFC. In all cases, the list of factors was agreed between the evaluation team and the Challenge. The main findings are summarised in Table 5 and Table 6, with factors ordered by the frequency at which respondents identified them as barriers and enablers in the final survey.

Table 5 Barriers to the progression of the future flight sector

Barrier	Baseline	Interim	Final
Brexit	61%	76%	75%***
Cost of inputs to production	n/a	68%	64%
Covid-19 pandemic	49%	60%	56%
Regulation	42%	57%*	51%
Size of the future flight workforce	n/a	46%	45%
Supply chain	16%	41%*	40%***

Barrier	Baseline	Interim	Final
Public perceptions	38%	41%	39%
Skills of the workforce	18%	40%*	38%***
Government policy	28%	38%	35%
Local authorities' engagement	n/a	37%	35%
Geopolitical instability	n/a	46%	34%**
Private sector investment	15%	29%*	32%***
Government funding or investment	12%	27%*	26%***
Pace of development of technologies	18%	34%*	21%**

Source: *Industry Survey. C5. For each of the following, please indicate whether you think they are a barrier or enabler to the progression of future flight technology in the UK.*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

In the final survey, consistent with the interim evaluation, three factors were reported by the majority of respondents as barriers to the sector: Brexit (75%), the cost of inputs to production (64%), and the regulation of future flight technologies (51%). Comparing the baseline and final evaluation surveys, notable increases in factors perceived as barriers to the sector were seen for the sector's supply chain (24 percentage point increase), workforce skills (20 percentage points) and private sector investment (17 percentage points), highlighting these factors as perceived growing constraints on sector development by survey respondents. Notably, respondents in the final survey did not perceive any barriers to be lower, on average, than they were at baseline.

The differences between responses at interim and final evaluation are smaller. Strikingly, the share of respondents who perceived the pace of technology development as a barrier fell from 34% at the interim evaluation to 21% in the final evaluation, a statistically significant decline. There was also a significant decline in geopolitical instability being perceived as a barrier, from 46% of respondents to 34% between interim and final evaluations.[7] However the top barriers at the interim evaluation remained similar in the final evaluation (Brexit, input costs, Covid-19 and regulation), albeit with a small drop in those who perceived regulation as a barrier. Notably, these are all barriers that the FFC has little influence over.

As organisations advance the maturity of their technologies, considerations around scalable and sustainable solutions become critical. As such, some barriers become more evident than others. For example, scaling up technology requires a robust supply chain to support industrialisation and commercialisation. Establishing a resilient supply chain demands forward planning, and the increased awareness of supply chain challenges reflected in the final survey

[7] This decline occurred despite ongoing global challenges such as the fuel crisis and other conflicts and the rise in the cost of living in the UK during the evaluation period, which might have been expected to heighten concerns about geopolitical instability.

may stem from this growing need as technologies progress. The ongoing development of the sector will require adaptation from industry, regulators, and government, including efforts to upskill their workforces. This need for upskilling may explain the observed trend in workforce skills being increasingly perceived as a barrier between the baseline and final evaluations (18% vs. 38%).

According to industry stakeholders interviewed, achieving meaningful progress toward establishing in-service operations requires several critical barriers to sector growth to be addressed. One significant challenge is the different operational pace between SMEs and large organisations. Driven by the need for rapid technical and commercial progress to sustain cash flow, SMEs are often more dynamic than larger organisations, which have more diversified income streams and complex approval processes. This disparity creates financial risks for SMEs, particularly when collaborating with larger partners, as delays in progress can lead to cash flow uncertainties and hinder the ability of smaller firms to remain competitive.

Another critical barrier identified by stakeholders interviewed is the slow pace of regulatory development in the UK, which directly affects the timeline for future flight service providers to generate stable revenue from operations. This regulatory uncertainty makes it challenging for businesses to secure investments and plan for long-term growth. Additionally, the capital intensity required to transition from technology demonstration to in-service operations presents a significant challenge, especially for SMEs. Many face difficulties in securing sustained private and public funding, and stakeholders noted that gaps in financial support could significantly reshape the SME landscape within the future flight sector in the next years.

Views on public perception as a barrier remained consistent across the baseline, interim, and final evaluations, with approximately 40% of respondents in each survey identifying it as a challenge. However, this stability may overlook underlying competing factors that influence perceptions in different ways. As technologies approach deployment, public opinions are increasingly shaped by available information. Negative public views could significantly hinder the sector, affecting investment and economic projections. Providing accurate and transparent data is therefore essential to foster a positive perception and ensure the anticipated benefits of future flight technologies are understood.

To address these issues, both government and industry have proactively engaged with the public, including through events hosted by FFC Demonstration Phase projects. These events aimed to explain technologies, use cases, and operations, providing clear and detailed information to build public understanding and support for the future flight sector. Evidence from the case studies suggests that the FFC's initiatives to raise public awareness about the benefits of future flight technologies have positively influenced perceptions of specific use cases (e.g., medical emergency response). This improved awareness has, in turn, driven greater demand from end-users for operational deployment and in-service applications.

In the final survey, five factors were identified by a majority of respondents as enablers for the future flight sector: government funding or investment (68%), pace of development of future flight technologies (60%), private sector investment (59%), government policy (54%), and

skills of the workforce (51%). However, in each case, the proportion of respondents who viewed these as enabling factors was lower in the final evaluation compared to the baseline. Notably, the differences for the pace of technology development and government policy were not statistically significant. This trend coincided with an increase in the proportion of respondents who perceived these same factors as barriers, underscoring their dual influence on the sector's growth.

Table 6 Enablers of the progression of the future flight sector

Enabler	Baseline	Interim	Final
Government funding or investment	86%	68%*	68%***
Pace of development of technologies	68%	49%*	60%
Private sector investment	80%	67%*	59%***
Government policy	63%	53%	54%
Skills of the workforce	75%	55%*	51%***
Supply chain	65%	46%*	46%***
Geopolitical instability	n/a	29%	46%**
Public perceptions	39%	39%	40%
Regulation	50%	35%*	38%***
Local authorities' engagement	n/a	44%	37%
Size of the future flight workforce	n/a	41%	32%
Covid-19 pandemic	41%	21%	22%***
Cost of inputs to production	n/a	13%	14%
Brexit	13%	8%	7%

Source: *Industry Survey. C5. For each of the following, please indicate whether you think they are a barrier or enabler to the progression of future flight technology in the UK.*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Differences between the interim and final evaluations regarding perceptions of enablers for the sector were relatively modest. The proportion of respondents who viewed the pace of technology development as an enabler increased from 49% to 60%, although this change was not statistically significant. Additionally, geopolitical instability was more frequently seen as an enabler in the final evaluation, likely due to a decline in the number of respondents who perceived it as a barrier compared to the interim evaluation.

In line with findings from case studies, the pace of development of future flight technologies was perceived as crucial to maintain UK competitive advantage, as was a comprehensive government policy that keeps up with this pace. Government funding plays a pivotal role by

mitigating risks for early-stage technologies, supporting infrastructure and regulatory alignment, and signalling commitment to the sector, which encourages further private sector investment.

3.2 Theme 1 – Has the technological readiness of future flight technologies been progressed as a result of the Challenge?

3.2.1 Overview

To assess this evaluation theme, we analysed the metrics summarised in Table 7.

Table 7 Theme 1. Technological readiness – Evaluation metrics

Subtheme	Metric	Data source
Consortia's technology readiness	Technology readiness level (TRL) at the start and end of engagement with the FFC	Survey data; monitoring data (new IP registered)
	Expected TRL at the start and realised TRL at the end of engagement with the FFC	Survey data
	Stated impact of FFC on technology readiness	Survey data
Technology readiness in the wider flight sector	Extent to which FFC has accelerated the development of future flight technologies in the UK	Case studies
Perceptions of ease of conducting demonstrations in the UK	Stated impact of FFC on ease of conducting demonstrations	Survey data
	Extent to which FFC has contributed to the ease of conducting demonstrations in the UK	Case studies

Source: Frontier Economics

Theme 1 – Key messages on technology readiness

- Survey findings suggest that competition consortia funded in the Demonstration Phase have increased their technological readiness, enabling projects to advance to higher levels of maturity.
- Evidence from case studies shows that the FFC has accelerated technological development in technologies that already had a high or medium TRL (e.g., unmanned aerial systems (UAS) and electrical vertical take-off and landings (eVTOLs)), but less so for hybrid-electric/hydrogen aircraft, and other supporting digital and physical infrastructure.
- Stakeholders interviewed noted that FFC-enabled demonstrations highlighted barriers and clarified costs and risks of deployment but were often described as limited in scale and lacking integration with broader aerospace operations. The approval processes of the Civil Aviation Authority (CAA) were widely seen as slow, posing challenges for timely advancements.
- SMEs interviewed expressed concerns about high demonstration costs and limited funding, calling for a sharper focus on well-defined use cases. Stakeholders emphasised the importance of prioritising technologies closer to commercialisation to create a clearer path to scalable in-service operations.

3.2.2 Aims and activities

A key objective of the FFC is to accelerate the technological and commercial maturity of future flight technologies, which is often measured and monitored by technology readiness level (TRL).[8] The FFC is focused on addressing six critical problem statements identified as priorities for the UK flight sector to unlock the economic, societal, and environmental benefits of emerging aviation technologies.[9]

At its inception, the FFC anticipated increasing the TRLs of supported future flight technologies across areas such as UAS, advanced air mobility (AAM), electric and hydrogen aircraft, and supporting infrastructure. The goal was to accelerate progress and enable earlier deployment of key innovations from 2021 onwards. Given that future flight technologies were at varying stages of readiness, it was expected that each would achieve different levels of progress. These advancements were also expected to benefit the broader future flight sector through

8 The highest level of TRL indicates a fully functioning and flight proven system in service. For more information and descriptions, see UKRI website.

9 The problem statements are: (1) drone applications are stifled by absence of physical and data infrastructure; (2) current air traffic management systems are not scalable; (3) need to develop autonomy while maintaining high levels of safety; (4) need to move towards more electric flight by creating pathways between urban, sub-regional class vehicles, and larger aircraft; (5) need to develop use cases and operational frameworks for the adaptation of autonomous air vehicles; (6) lack of aviation innovation or development environment that allows real-life demonstrations and evaluation of these problem statements.

technology transfer processes, although such benefits could be limited by intellectual property (IP) constraints. Without FFC support, it was assumed that the sector would still advance, albeit at a slower pace, as technological progress would primarily rely on private returns and alternative funding sources.

To achieve this goal, the FFC provided funding to competition winners, enabling them to advance their innovations, while also fostering knowledge transfer across the future flight sector. Across the Development (2021-2022) and Demonstration Phases (2022-2025), the FFC allocated approximately £100 million in grants to support 51 competition projects with the involvement of 192 distinct organisations.[10] During the Demonstration Phase alone, around £70 million was allocated to 17 projects focused on delivering live demonstrations in representative environments with real-world use cases involving UAS, AAM, and electric regional aircraft. These projects were carried out by consortia comprising nearly 120 distinct organisations from across the future flight sector. A critical objective of the Demonstration Phase was to advance cross-cutting technologies essential for ensuring the safe and effective operation of new classes of air vehicles.

Demonstration Phase (2022-2025) – Winning projects

- **SafeZone Phase 3**: Investigates localised data to allow UAS to adapt their route as they fly through wind changes and close to buildings at Cardiff Airport and will create a live data service providing real-time information about air hazards in the urban landscape. Led by Zanotech.
- **InDePTH**: Uses drones to regulatory survey wide infrastructure estates, including ports and highways, to create digital models and obtain detailed insight on these environments. Led by BT.
- **Project PORTAL:** Develops a scalable, reconfigurable, and rapidly deployable automated vertiport capability that will serve permanent vertiports, new bespoke vertiports, and retro-fitted installations on car parks or roof tops and will support temporary operations as a pop-up vertiport for events or disaster relief. Led by SLINK-TECH.
- **ALIAS – Agile Integrated Airspace System**: Demonstrates a scalable airspace system that will integrate drones, air taxis, and manned aircraft in the Channel Islands. Led by Volant Autonomy.
- **Project BLUEPRINT**: Aims to create and demonstrate digital infrastructure and operational procedures that will allow safe and efficient integration of beyond visual line of sight (BVLOS) operations with other airspace users. Led by Neuron Innovations.
- **FFLIP – Future Flight and Land Infrastructure Programme**: Will deliver a full-scale multi-modal demonstration at a site in Oxfordshire, including an electrical vertical take-off

[10] This excludes 14 Covid-19 short-term projects (£3.5 million), five projects funded through the collaboration between Innovate UK's Small Business Research Initiative (SBRI) and the Department of Health and Social Care (DHSC) (£0.5 million), 13 skills mini competitions (£0.5 million), and Connected Places Catapult's (CPC)'s Accelerators (£0.5 million).

and landing (eVTOL) charger infrastructure with multiple power configurations to support charging of electric ground vehicles, trucks, drones, and eVTOL aircraft. Led by Petalite.

- **Air Mobility Ecosystem Consortium:** Aims to demonstrate the commercial and operational viability of AAM in the UK through flights between a new Skyports vertiport and London Heathrow and Bristol airports using Vertical Aerospace's eVTOL aircraft, operated by Virgin Atlantic. Led by Atkins.
- **Protecting environments with uncrewed aerial vehicle (UAV) swarms:** Will demonstrate how UAV can be used to conduct environmental protection missions including gathering environmental data in Antarctica and the detection and location of wildfires. Led by Windracers.
- **CAELUS 2:** Aims to show the operation of a network of multiple electric drones for the distribution of medical products and medicines across Scotland. Led by AGS Airports.
- **Skyway:** Will use drones powered by renewable energy sources on a superhighway connecting the airspace above cities including Reading, Oxford, Milton Keynes, Cambridge, Coventry, and Rugby. Led by Altitude Angel.
- **Project SeaWatch:** Low-cost contribution to maritime surveillance, via an autonomous UAV with a specially adapted, artificial intelligence (AI) enabled 3D camera system. Led by UAVAid.
- **Open Skies Cornwall:** Will implement the DronePrep Drone Delivery Register, which will help with planning and building sky highways to connect NHS, Royal Mail, maritime, and local authority assets to the people of Cornwall. Led by Droneprep.
- **HADO:** Will evaluate a live commercial autonomous BVLOS drone service in the high intensity airspace of Heathrow Airport. Led by Operational Solutions.
- **Project HEART – Phase 3:** Will demonstrate a viable regional transport network, aimed at sub-regional aviation (9-19 passengers), conducting flight trials with automated specialised operations aircraft powered by zero-carbon hydrogen electric systems. Led by Blue Bear Systems Research.
- **Morecombe Bay Medical Shuttle 2:** Will use solar powered drones to shuttle pathology samples between three hospitals in north-west England. Led by Digital & Future Technologies.
- **Atypical Airspace BVLOS Solution (AABS):** Will develop a platform for UAS to map its surroundings in 3D to allow for autonomous flying at low altitude and near obstacles. Led by Sees.ai.
- **Sustainable Aviation Test Environment 2:** Will create a UK Centre for Sustainable Regional Aviation Systems, enabling pre-commercial demonstrations of novel aviation technologies at Kirkwall Airport (Orkney Islands).

Advancements in TRL were expected to contribute directly to the development of future flight clusters (see Section 3.9) and accelerate the deployment of technologies tailored to meet UK-specific requirements (see Section 3.11). A key enabler for achieving these outcomes was the sector's regulatory readiness, particularly the availability of regulatory sandboxes. These sandboxes provided competition winners with safe, controlled environments to develop and

test their technologies, ensuring they meet safety and compliance standards while fostering innovation and accelerating market entry.

The project portfolio review conducted by Frazer-Nash Consultancy in 2022 as part of the interim evaluation found that projects supported during the Demonstration Phase addressed several key priority areas outlined in the Future Flight Vision and Roadmap,[11] including intellectual property, digital infrastructure, and communications. However, relatively few projects concentrated on energy infrastructure and electronic conspicuity. In particular, the project portfolio review highlighted that electronic conspicuity is a critical enabler for BVLOS operations, suggesting this area could benefit from targeted future investment to support the sector's advancement.

The interim evaluation revealed that the FFC had accelerated technological development in areas with medium to high TRLs, such as UAS and eVTOLs, as well as in non-core technologies such as batteries for electric aircraft and charging stations. At the time, industry stakeholders highlighted two critical enablers for further progress: developing the necessary digital and physical infrastructure to support new electric and autonomous air vehicles and expanding the CAA's capacity to facilitate trials, demonstrations, and in-service operations. However, some consortia reported challenges in obtaining BVLOS demonstration approvals, which hindered their ability to meet project objectives.

3.2.3 Evaluation evidence

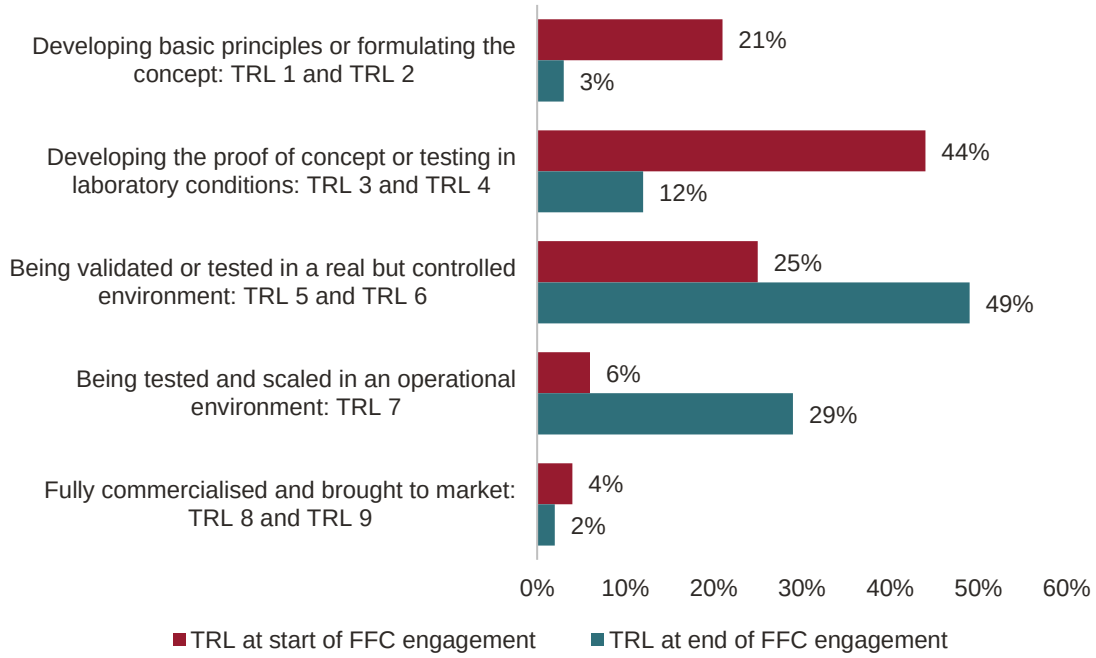
Effect of competition participation on technology readiness levels

All respondents with a project funded by the FFC were asked to report the TRL of their project at the start of their engagement. Respondents involved in the Demonstration Phase were also asked to provide the TRL that their project had achieved by the end of that phase. As shown in Figure 5, the proportion of projects at TRL 1 or 2 decreased significantly from 21% at the start of the phase to only 3% by the end of this phase. Projects at TRL 3 or 4 saw a decline from 44% to 12%, while those at TRL 5 or 6 increased from 25% to 49%. The proportion of projects reaching TRL 7 rose substantially, from 6% to 29%, and one project reported achieving a TRL of 8 or 9 by the end of the Demonstration Phase.

Overall, 71% of survey respondents involved in the Demonstration Phase reported that the TRL of their project had increased by the end of their engagement with the Challenge, while 27% stated that the TRL had remained the same as it was at the start of their engagement. This highlights the role of the Challenge in advancing technological maturity for the majority of participants.

11 UKRI/Innovate UK (2021) Future flight vision and roadmap

Figure 5 TRL at the start and end of engagement with the FFC: Demonstration Phase



Source: *Industry Survey. D9. At the start of your engagement with the FFC, what stage of development was the technology at in terms of technology readiness level (TRL)? D13. After your engagement with the FFC, what stage of development was the technology at in terms of TRL?*

Note: *Base: valid responses, successful applicants – Demonstration Phase (D9: 111, D13: 59). Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

These results are consistent with available FFC project close-out data for the Demonstration Phase, where all 25 respondents from five projects with available information indicated an increase in TRL, with half reporting an increase from TRL 3 to TRL 6. During the interim evaluation, it was found that 13 out of 15 organisations reported an increase in TRL. However, as there were 34 and 17 projects funded in the Development and Demonstration Phases, respectively, these results are subject to non-response bias.

IP protection activities provide further evidence that consortia advanced their technologies during the competitions. Project close-out data indicates that five out of 25 respondents were considering applying for IP protection by the end of the phase, while six had already applied for or been granted IP rights. Similarly, during the interim evaluation, most of the 15 organisations with available information were also considering applying for IP protection, with four projects having already applied for or been granted IP rights. Although available data is limited and subject to non-response bias, this may suggest the key role of FFC competitions in fostering innovation and protecting technological developments.

Evidence from the case studies indicates that, before the Challenge was launched, organisations were deploying future flight technologies in a limited and exploratory capacity,

primarily to evaluate the feasibility of integrating innovations like drones into their existing operations (e.g., maintenance/inspection). Industry stakeholders noted that regulatory barriers, particularly for BVLOS trials, constrained technology operators and limited their ability to showcase the potential benefits of these advancements. Flight hours for drone operations were substantially lower than current levels, with some organisations citing this inactivity as a key factor leading to a "stall" in investment. Additionally, concerns about the impact of Brexit on airspace rules and regulations introduced further uncertainty, prompting some organisations to pause investments until a clearer path to in-service operations emerged.

Following the Challenge's intervention, both SMEs and large organisations reported notable advancements in technology development. Evidence from case studies indicates that the Challenge offered valuable insights into costs, requirements, and challenges, effectively reducing the "unseen risks" that previously discouraged internal investment. This support has allowed many companies to refine their understanding of potential use cases, develop strategies focused on future flight technologies such as UAS, eVTOL, and hydrogen aircraft, and identify new business opportunities.

> *"The Challenge provided a vehicle for UK start-ups to pave the way for urban and advanced air mobility." – Industry stakeholder (SME)*

> *"Without the Challenge, we would still be thinking about these technologies, but not acting on it." – Industry stakeholder (Large organisation)*

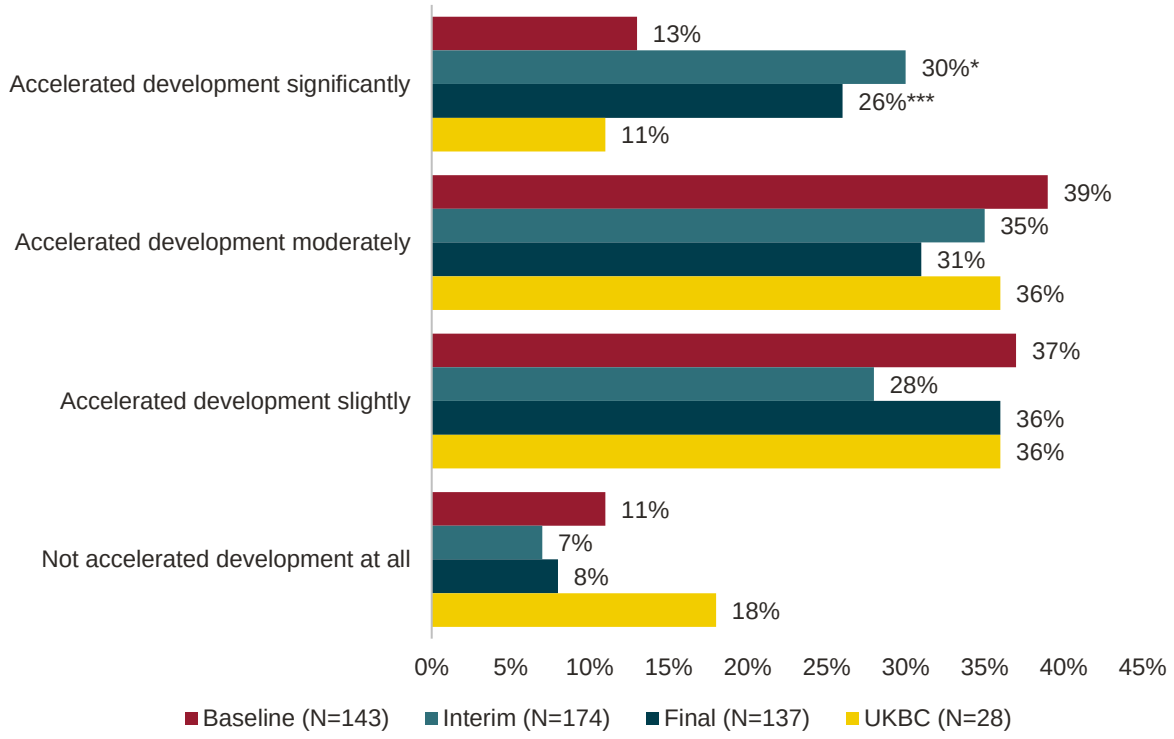
Although most large organisations expressed optimism about the transformative potential of future flight technologies, some noted that these innovations might not directly benefit their current operations. Nonetheless, they acknowledged the Challenge's role in helping them explore the possibilities of adopting these technologies, broadening their understanding of how such innovations could be effectively integrated into their operations.

> *"We now have a strong understanding of what the sector looks like." – Industry stakeholder (Large organisation)*

Effect on technology readiness in the future flight sector

In addition to advancing the technology readiness of competition projects, the FFC aims to accelerate technological development across the wider future flight sector. As shown in Figure 6, 26% of respondents in the final evaluation survey stated that the FFC had significantly accelerated technological development compared to 13% in the baseline survey, a statistically significant difference but similar to the interim evaluation where 30% reported this perception of the Challenge. Furthermore, over nine in ten respondents (91%) indicated that the FFC had at least some accelerating impact on technological development, highlighting its broader influence on the sector. As expected, perceptions of UK Business Connect (UKBC) organisations were slightly more negative as these represent organisations that have not engaged with FFC's competitions directly.

Figure 6 Extent to which FFC has accelerated the development of future flight technologies



Source: *Industry Survey. G2. Thinking about the Future Flight Challenge overall, how much do you think it has accelerated development of future flight technologies in the UK?*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Industry stakeholders interviewed acknowledged that the FFC provided substantial support for various valuable use cases, focusing on technologies such as eVTOL and UAS but less so on other technologies like hydrogen aircraft or supporting infrastructure. In particular, interviewees emphasised the importance of prioritising enabling infrastructure alongside air vehicles to ensure successful integration within a system-of-systems framework. Key areas identified as requiring greater focus included digital technologies, air vehicle infrastructure, and hydrogen, which were viewed as critical components for advancing the future flight ecosystem. This aligns with findings from the interim evaluation.

> *"The sector would be significantly further behind without the Challenge." – Industry stakeholder (SME)*

Some SMEs expressed concern that resources were spread too broadly across numerous areas, potentially limiting the ability to prioritise and advance specific technologies toward in-service provision, particularly foundational ones. There was a perception among interviewees that funding a broad spectrum of use cases limited the potential to achieve significant progress or impact on well-defined use cases. Some organisations suggested that concentrating efforts and investment on technologies and use cases closer to commercialisation would be more

impactful. They argued that successfully bringing these to market could lay the groundwork for future adoption and advancement of other innovations.

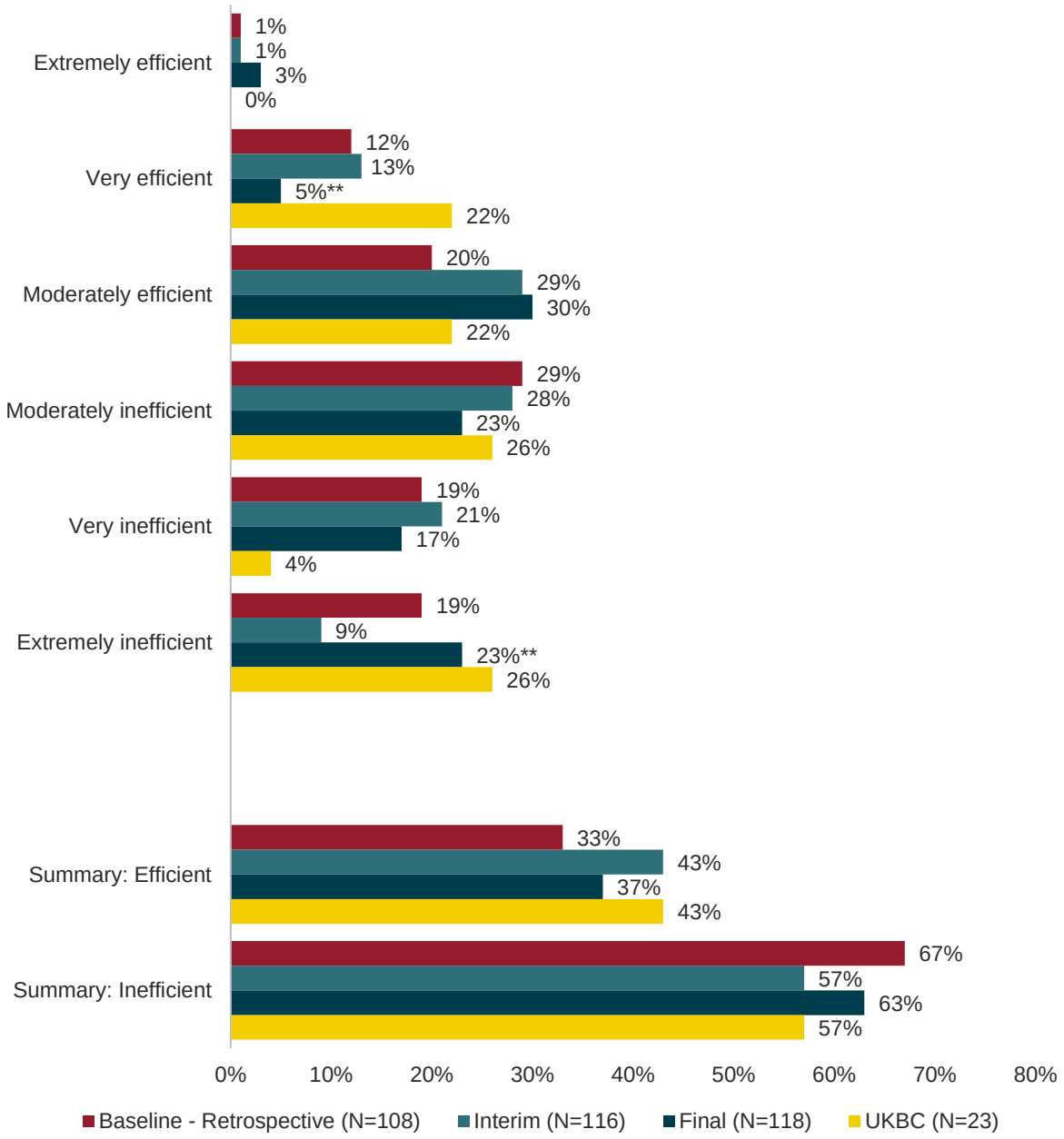
> *"We are focusing on too many use cases and technologies that traction on a specific use case is not being captured." – Industry stakeholder (SME)*

Ease of conducting demonstrations

As identified in the interim evaluation, a key enabler of the progression of future flight technologies is the ease of conducting demonstrations, particularly the efficiency and effectiveness of the CAA demonstration approval process. Demonstrations are vital as they provide opportunities to test, validate, and refine technologies in real-world or representative environments. They also help address technical, operational, and regulatory challenges, ensuring that the technologies are practical, safe, and compliant with performance standards.

Survey respondents across all survey waves were asked about the efficiency of the CAA approval process for conducting demonstrations, with the results shown in Figure 7. In the final survey, perceptions remained predominantly negative, with 63% of respondents considering the process inefficient. Notably, 23% described it as "extremely inefficient", a statistically significant increase from 9% in the interim survey. Conversely, the proportion of respondents who found the process "very efficient" dropped significantly, from 13% in the interim survey to just 5% in the final survey.

Figure 7 Efficiency of CAA approval process for conducting demonstrations



Source: *Industry Survey. C4A. How efficient was the CAA approval process for conducting demonstrations in the UK in 2019 at the start of the FFC? C4B. How efficient is the current CAA approval process for conducting demonstrations in the UK?*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

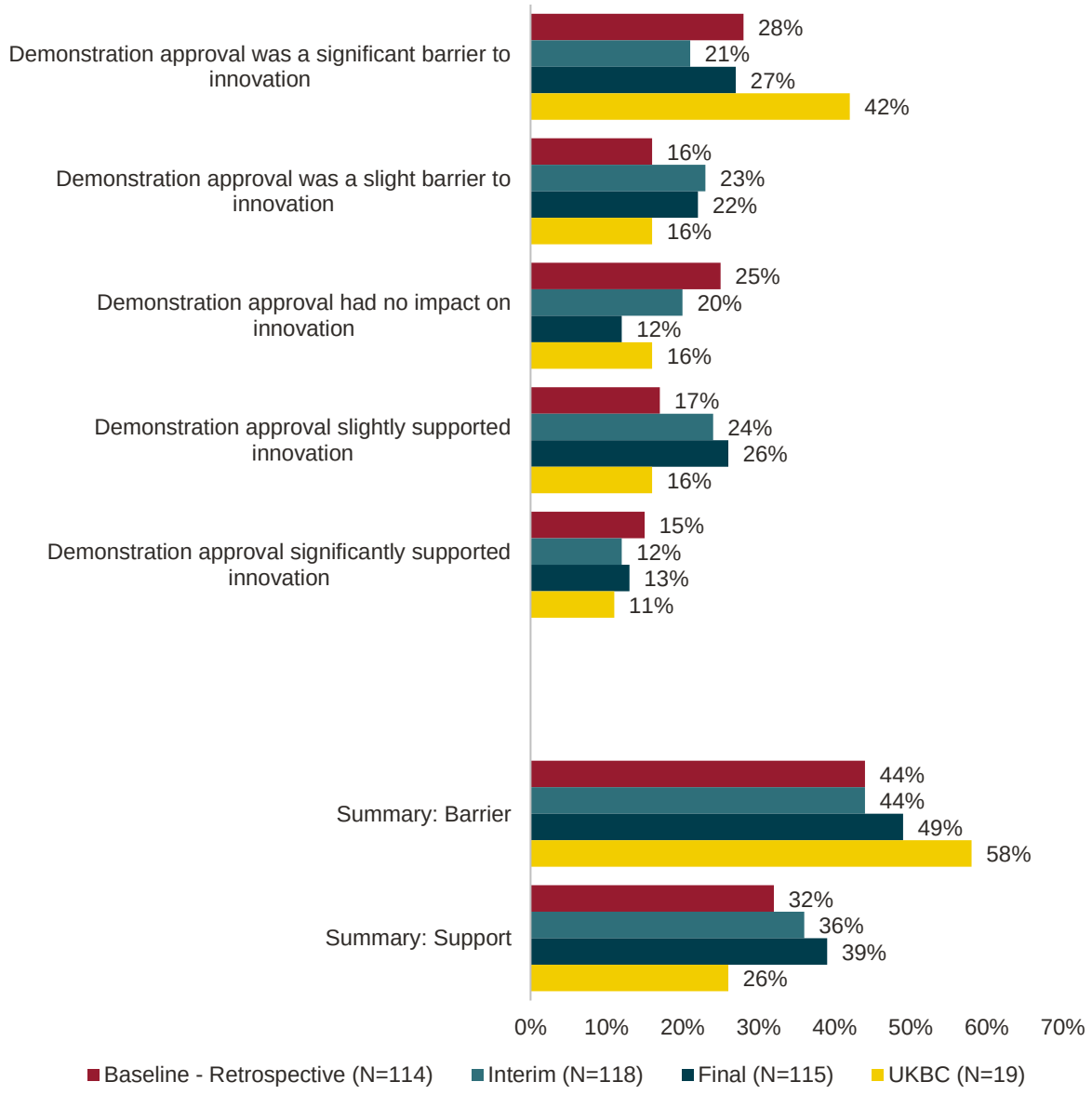
Among subgroups, respondents working on electric, hybrid-electric, or hydrogen regional aircraft were more likely than average to view the CAA approval process as efficient. Based on expert input, one possible explanation for this finding is that crewed aircraft technologies, such as regional aircraft, share similarities with existing test aircraft in terms of flight operations and air traffic services, areas where the CAA has considerable experience. Compared to the

interim survey, organisations working on UAM technologies have a more positive perception of the CAA's process to conduct demonstration (47% vs 31%).

Notably, perceptions about the efficiency of the CAA approval process were more negative in the final survey compared to the interim survey. This shift is not surprising, as the Demonstration Phase, unlike the Development Phase, focused on conducting trials in representative environments. As the final survey was conducted toward the end of this phase, whereas the interim survey was conducted at the beginning, consortia had gained more experience engaging with the CAA to secure approvals, leading to an increase in both the complexity and frequency of interactions with regulators. Moreover, the volume of flight approval requests directly affected processing times, contributing to the perceived inefficiencies.

Respondents were also asked to evaluate the extent to which the CAA's demonstration approval process supported future flight innovation (Figure 8). A greater proportion viewed the process as a barrier to innovation (49%) rather than as an enabler (39%). Moreover, perceptions of the current process were less positive to those in the baseline and interim evaluations (44% perceived as a barrier), indicating little change in how the process is viewed in terms of its impact on fostering innovation.

Figure 8 Extent to which the CAA's demonstration approval process supports future flight innovation



Source: *Industry Survey. C4D. In 2019, to what extent did the CAA's demonstration approval process support future flight innovation? C4E. Currently, to what extent does the CAA's demonstration approval process support future flight innovation?*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Evidence from the case studies highlights that the FFC's competitions have significantly accelerated the demonstration of certain future flight technologies since the Challenge's inception, particularly for BVLOS operations. Industry stakeholders emphasised the critical role these demonstrations play in identifying implementation barriers, providing insights to shape future business cases and regulatory frameworks, and clarifying associated costs and

risks. As a result, these demonstrations are viewed as essential steps for translating innovation into scalable in-service operations.

However, many large organisations interviewed noted that significantly more testing was required to advance toward viable on-service operations and "move the dial on regulation". Demonstrations facilitated by the CAA during the Demonstration Phase were described as "small scale" and "not integrated" with other aerospace users and services. According to stakeholders interviewed, isolated operations in restrictive areas (e.g., temporary danger areas or temporary reserved areas) used by the CAA to test future flight technologies are not representative of the future flight environment.

While organisations interviewed recognised these demonstrations as an important initial step in a long-term journey, there was a strong expectation of a significantly higher volume of flight tests to better bridge the gap between future use cases and in-service operations. This had created uncertainty among organisational decision-makers about the future direction of flight technologies. They viewed further investment concentrated solely on R&D without a clear path to commercialisation as a potential setback rather than progress. Large organisations stressed that future government initiatives should focus on speeding up the pace of demonstrations to bridge the gap between TRLs and the CAA's approval timelines.

Stakeholders also highlighted the high costs associated with such demonstrations, which pose a particular challenge for SMEs with limited financial resources. Furthermore, some SMEs suggested that progressive and iterative demonstrations, focused on a limited number of well-defined use cases and supported by updated regulatory guidance, would be more effective in fostering public acceptance and strengthening viable commercial models.

Finally, there is evidence from the case studies that demonstrations facilitated by the Challenge have produced invaluable data and insights, providing essential guidance on how safe and assured flight operations might transition into service. However, while the involvement of the CAA was widely perceived as a significant advantage, some large organisations expressed concern about the limited data sharing across the wider future flight community. They highlighted that greater transparency and dissemination of findings could help reduce duplicated efforts, enabling organisations to refine their own operations based on the progress and lessons learnt from previous trials.

3.3 Theme 2 – Has the Challenge increased collaboration within the future flight sector, and between the sector and other stakeholders?

3.3.1 Overview

To assess this evaluation theme, we analysed the metrics summarised in Table 8.

Table 8 Theme 2. Collaboration – Evaluation metrics

Subtheme	Metric	Data source
Collaboration between future flight organisations	Stated impact of the FFC on collaboration	Survey data, Case studies
Knowledge sharing between the FFC and future flight companies	Impact of the FFC on knowledge sharing	Survey, FFC (UKBC) website activity measures
Trends in collaborations outside of Challenge consortia	Number of new collaborations between future flight sector companies, end-users, non-aerospace organisations, international companies, academics; between large and SME companies	Survey data

Source: Frontier Economics

Theme 2 – Key messages on collaboration

- Survey and case study evidence indicates that the FFC has facilitated collaboration at a scale and level of complexity that would not have been achieved without the initiative.
- It has contributed to the joint delivery of future flight technologies and services that otherwise would have been developed in isolated workstreams, at a slower pace, or not at all.
- Stakeholders highlighted the Challenge's role in creating a cohesive future flight community, encouraging cooperation among organisations that would not otherwise have engaged with each other.
- The collaborative environment has been supported by open communication, workshops, and events that have enabled knowledge sharing and aligned efforts toward shared goals.
- Interviews show that the Challenge has promoted international collaboration and visibility for UK organisations through events like DroneX and the Farnborough Airshow. SMEs reported gaining interest from international partners and funders, although non-UK organisations noted challenges with UK regulations and incentives, favouring European markets.
- Survey findings indicate that FFC publications, including roadmaps and case studies, were widely regarded as helpful by stakeholders, particularly among winning consortia, offering valuable sector insights. Monitoring data from UKBC further supports this, showing spikes in FFC website views coinciding with the release of these documents.

3.3.2 Aims and activities

The FFC aims to foster stronger connections between large, established companies in the future flight sector and a diverse range of stakeholders, including SMEs, government policymakers, regulators, local authorities, end-users, and international players. In its business case, the FFC emphasised that large and diverse consortia are particularly suited to addressing its problem statements. Such collaborations draw on a wide range of expertise and capabilities, enabling participants to effectively tackle the technical, regulatory, and social challenges needed to develop, test, and deploy future flight technologies at scale.[12] Knowledge exchange and collaboration, both within and beyond the future flight sector, are essential drivers for fostering clusters and enhancing the sector's contribution to the economy.

The FFC anticipated that its impact on collaboration would become evident from 2021 onwards, playing a critical role in fostering future flight technology clusters and accelerating the deployment of technologies tailored to UK-specific needs. It assumed that greater collaboration within the future flight sector and with external stakeholders would facilitate knowledge sharing and the creation of new connections, even in the absence of formal support from UKBC or FFC knowledge exchange initiatives.

The FFC expected that the stronger links fostered across stakeholders would not have occurred organically without its support. While some connections might have naturally formed as the sector matured – through routine business interactions or intermediary organisations like the Connected Places Catapult (CPC) or Nesta – these interactions were expected to remain limited, reflecting historical trends in the sector.

Improved collaboration between the future flight sector and end-users, policymakers, and regulators was also expected to accelerate the deployment of technologies by ensuring they align with UK-specific requirements, government priorities, and user needs. Additionally, this collaboration was anticipated to support the development of regulatory frameworks (see Section 3.4) and contribute to government policy (see Section 3.6). While some degree of communication among these stakeholders would likely have occurred independently, the FFC aimed at playing a key role in amplifying and structuring these interactions to achieve broader and more impactful outcomes.

To foster these connections, the FFC required companies that applied to competitions to form large and diverse consortia. This approach was designed to strengthen collaboration between newer SMEs and larger, more established companies in the future flight ecosystem. For the Development (2021-2022) and Demonstration Phases (2022-2025), project leads were required to include at least one registered SME or be an SME themselves. Depending on the competition strand, the FFC also required or encouraged consortia to include end-users, operators, and engagement with local authorities to ensure broader stakeholder involvement and practical applicability.

12 KTN (2022) Future Flight Challenge. Innovate UK KTN Interim Report 2020 - 2022

The FFC aimed to improve information and knowledge exchange to strengthen collaboration within consortia, between consortia and adjacent supply chain sectors, and between future flight sector and policymakers. Specifically, UKBC (formerly the Knowledge Transfer Network) facilitated knowledge exchange activities designed to help the sector better understand government policy directions while ensuring that policymakers were more informed about the sector's needs. With this objective mind and to encourage collaboration among stakeholders during the Demonstration Phase (2022-2025), the FFC implemented various activities including: (1) knowledge exchange events, (2) within-sector and cross-sector webinars, (3) networking events, and (4) rapid-fire interactions with investors. These initiatives aimed to facilitate meaningful engagement and foster stronger connections across the future flight ecosystem.

Demonstration Phase (2022-2025) – FFC events

- Between 2022 and 2024, as part of the Demonstration Phase, the FFC, Innovate UK and UKBC hosted a series of online and in-person events attended by nearly 1,500 participants.[13] These events were designed to promote collaboration and facilitate knowledge sharing among stakeholders in the sector. They included:
  - An event with Net Zero Places Innovation Network for local authorities;
  - A series of webinars focused on skills and training gaps in the sector;
  - A presentation of the skills competition for potential applicants;
  - A series of webinars focused on challenges and opportunities for investing and scaling companies in the future flight sector;
  - Rapid-fire interactions with investors (as part of the Future Flight Investor Office Hours programme) for companies that were in the process of raising capital and would benefit from connections to the early-stage investment community;
  - A networking event organised by the Cross-Sector Battery Systems Innovation Network;
  - A networking event for private investors and experts of the future flight sector; and
  - A presentation of the Future Flight Standards Programme, led by the British Standards Institute (BSI) and backed by UKRI, and the connection with regulations led by the CAA.

The 2023 interim evaluation found that the FFC's competitions brought together diverse organisations at a scale and complexity that would not have occurred otherwise. This included collaborations between end-users, commercial airlines, academia, government agencies, local authorities, operators, newer companies and older companies, incumbents and SMEs/start-ups, and international companies operating in the UK. At the time, both public sector and industry stakeholders indicated that the FFC had bridged a communication gap between the industry and central government, especially with the Department for Transport (DfT), the (then) Department for Business, Energy and Industry Strategy (BEIS) and the CAA.

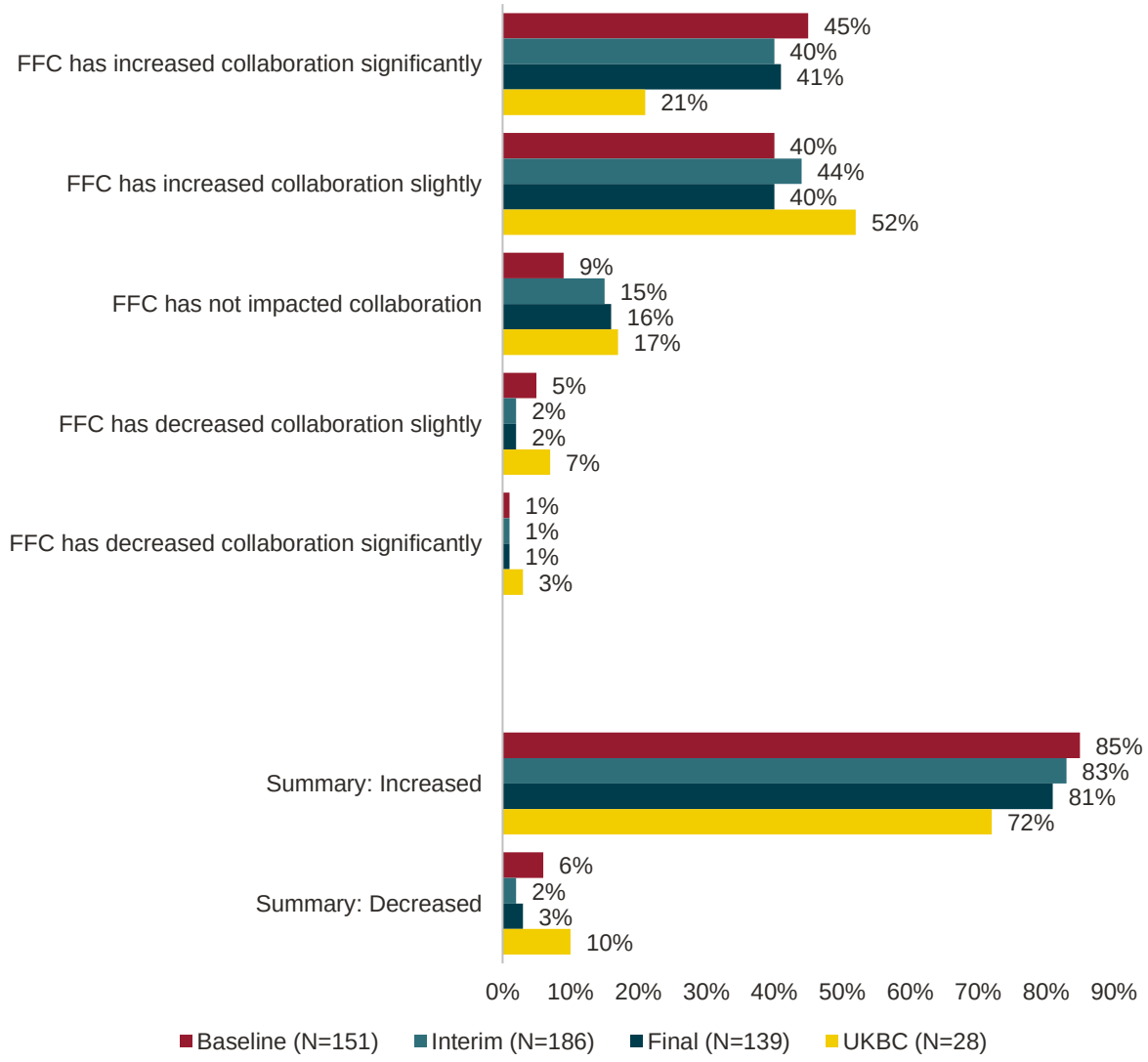
13 UKBC monitoring data.

3.3.3 Evaluation evidence

Effects of the FFC on collaboration

Survey respondents expressed a very positive overall view of the Challenge's impact on collaboration, as illustrated in Figure 9. Consistent with the baseline and interim survey, over four in five respondents (81%) felt the Challenge had increased collaboration to some extent, including 41% who believed it had done so significantly. Only 3% felt it had had a negative impact. These figures remained quite consistent across the baseline, interim, and final evaluations, suggesting that the positive collaboration benefits of the Challenge were perceived early on but have not necessarily increased over time.

Figure 9 Impact of the FFC on collaboration



Source: *Industry Survey. E3. How much do you think the Future Flight Challenge has impacted collaboration in general?*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

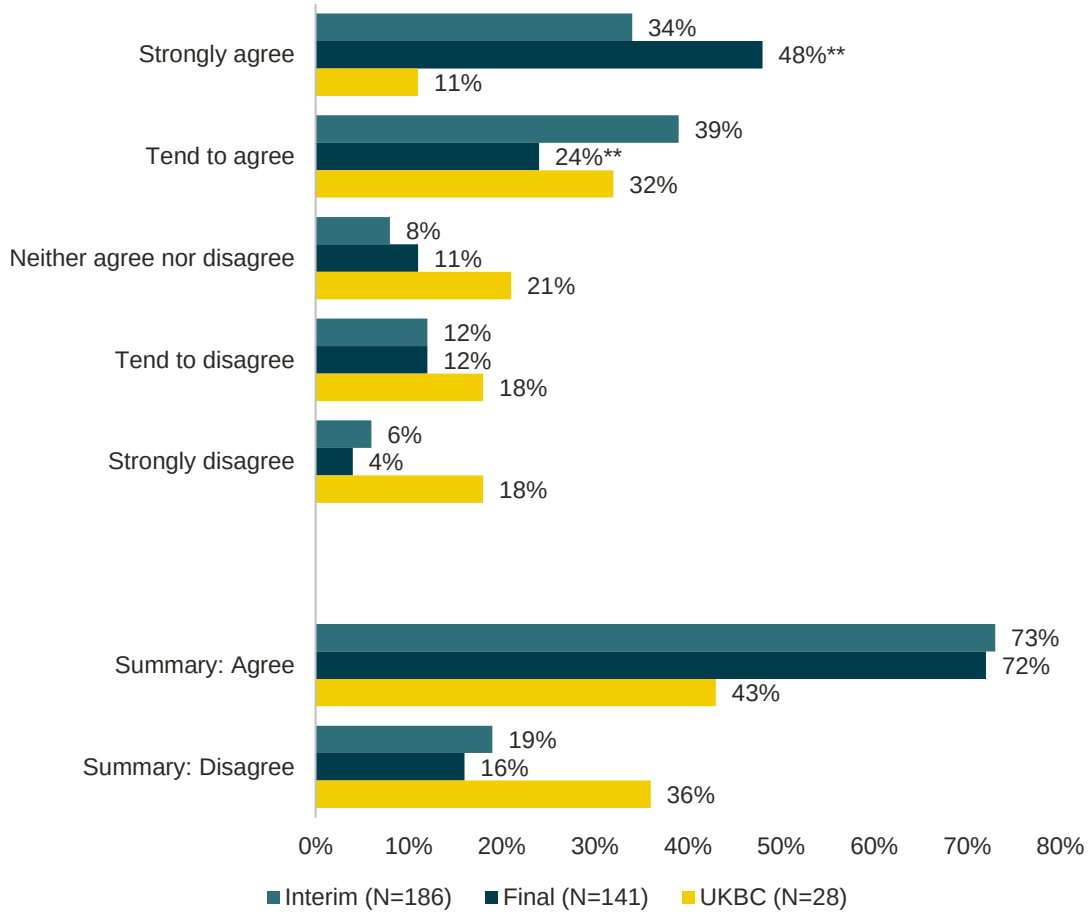
Respondents with at least one successful application were significantly more likely to agree that the FFC had increased collaboration (92%) compared to those whose applications had all been rejected (74%). UKBC contacts also expressed a positive view on the FFC's effect on collaboration, which aligns with their own involvement in UKBC events and webinars, albeit they were somewhat less likely to say the impact had been significant.

Overall, there was a consensus among industry stakeholders interviewed that the FFC had been a "gamechanger" by contributing to the joint delivery of future flight technologies and services that otherwise would have been developed in isolated workstreams, at a slower pace, or not at all. Industry stakeholders interviewed highlighted that before the Challenge, the sector was characterised by limited collaboration, with organisations often viewing each other as competitors rather than partners. All organisations interviewed highlighted that the relationships established during the Challenge were likely to extend into future programmes or funding opportunities. This demonstrates the emergence of a future flight community, where stakeholders remain connected, collaborate effectively, and work alongside one another, even among those traditionally seen as competitors.

> *"[The FFC allow us] to work collaboratively with partners and competitors alike to move the industry forward." – Industry stakeholder (Large organisation)*

Figure 10 below highlights respondents' perceptions of the FFC influence in encouraging collaboration between organisations from different disciplines within the future flight sector. While the overall share of respondents who felt that the Challenge had positively influenced interdisciplinary collaboration remained similar between the interim and final evaluations, there was a significant increase in those who "strongly" agreed with the statement, rising from 34% in the interim survey to 48% in the final survey. In contrast, responses from UKBC stakeholders showed lower agreement levels, potentially reflecting the lower overall level of engagement that these firms had had with the Challenge. These results highlight the Challenge's role in fostering meaningful partnerships within the future flight ecosystem, despite some variation in perceptions across groups.

Figure 10 Influence of the FFC on encouraging organisations from different disciplines of the future flight sector to work together



Source: *Industry Survey. B10. How much do you agree or disagree that the Future Flight Challenge competition process has encouraged organisations from different disciplines of the future flight sector to work together?*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

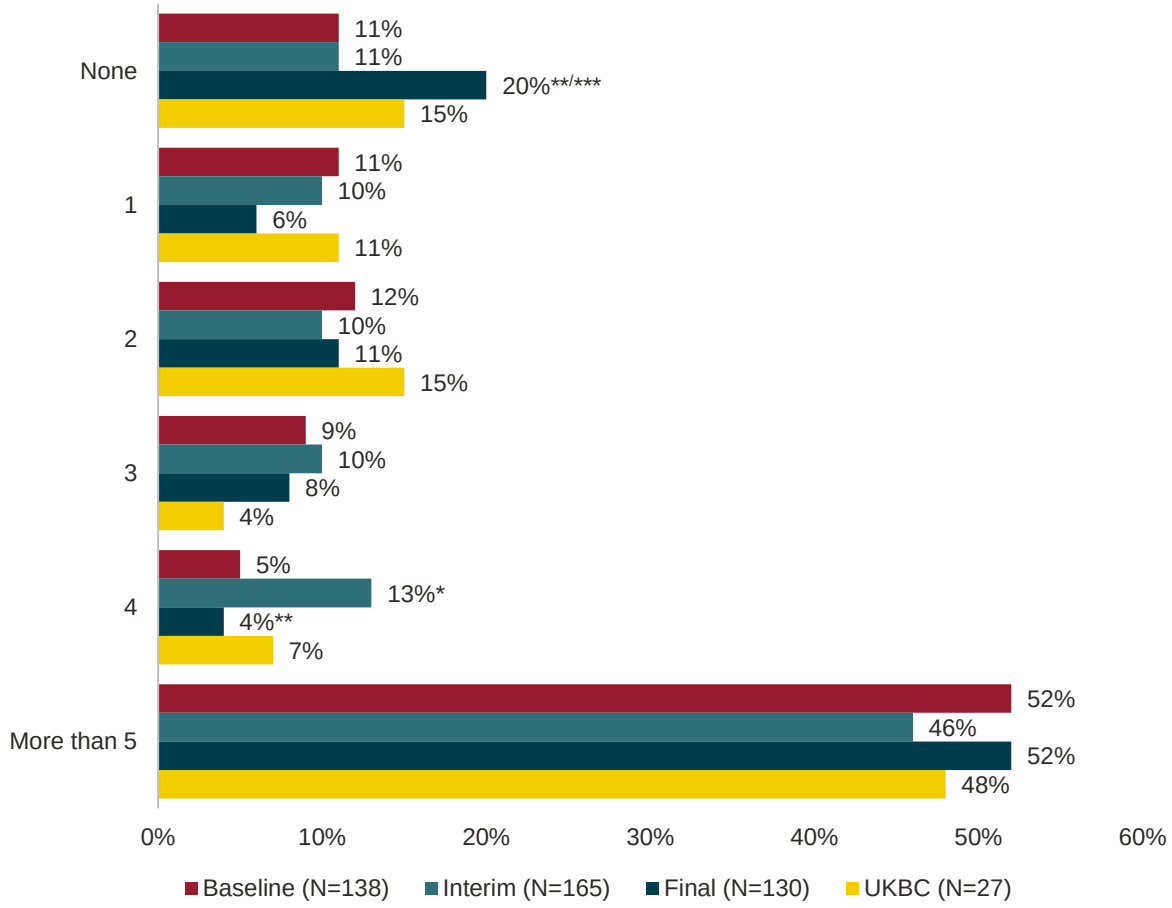
Trends in collaboration within and outside the future flight sector

The FFC has sought to promote collaboration both within consortia and across the broader sector. However, attributing sector-wide trends in collaboration to specific FFC activities is inherently challenging. While survey evidence provides insights into the FFC's influence, it is important to acknowledge that some trends in collaboration may have occurred independently of the FFC's interventions.

Survey respondents were asked about the number and types of partners they were collaborating with on future flight sector projects outside of their FFC consortium. Figure 11 indicates that over half of the respondents (52%) reported collaborating with more than five organisations beyond their consortium. These results are consistent across survey waves and show no significant differences between competition applicants and UKBC contacts,

highlighting the broad and sustained collaborative engagement within the sector. These findings suggest that, while consortia were already collaborative, they still perceived the Challenge as having a positive impact on further strengthening collaboration in the sector.

Figure 11 Scope of collaboration within future flight sector



Source: *Industry Survey. E1. Number of businesses within aviation/future flight companies collaborating with.*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Table 9 shows the proportion of respondents who were collaborating with various stakeholder groups and the average number of collaborations for each group. The most frequent collaborators include non-aviation SMEs, regulators and policymakers, and researchers. Between the interim and final surveys, there was an overall increase in both the rate of collaboration with each type of partner and the average number of partners per respondent. The only exception was collaboration with large organisations, which did not show a similar trend. This is consistent with the evidence above that these were already collaborative firms on average which nevertheless saw an increase in collaboration over time after engaging with FFC.

Table 9 Number of collaborations outside FFC consortia, by type

Type	% of respondents collaborating with this group			Average number of collaborations with this group, per respondent		
	Final	Interim	Baseline	Final	Interim	Baseline
SME non-aviation future flight sector companies	75%**	43%	49%	3.5	2.8	2.9
Regulators and policymakers	74%**	48%*	53%	1.5	1.2	2.1
Researchers	69%	60%	66%	4.0	3.6	3.9
SME aviation companies	60%	57%	65%	4.1	4.0	4.5
End-users	55%	50%	59%	5.1	3.9	4.9
Companies outside future flight sector	41%	42%	48%	3.7	3.4	4.2
Large aviation companies	38%	42%	47%	1.9	1.6	2.4
Large non-aviation future flight sector companies	30%	32%	38%	1.8	1.2	1.6

Source: *Industry Survey. E1. Outside of your FFC consortium, how many of the following types of partners are you collaborating with on future flight sector projects?*

Note: *Base: all responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Evidence from the interviews also highlights that collaboration has been a cornerstone of the Challenge, with evidence from case studies highlighting its role in fostering the development of a cohesive "future flight community" that has brought together SMEs, large organisations, government, and regulator stakeholders, all aligned around a shared vision rather than an isolated or competitive one. This collaborative effort, facilitated by a “neutral organisation” like the Challenge, was seen by stakeholders as pivotal in driving progress and fostering innovation in the future flight ecosystem.

Industry stakeholders also acknowledged that the Challenge facilitated “honest conversations” on key challenges facing the sector, such as regulatory barriers and funding gaps. These open discussions were viewed as essential for building trust and respect within the community, strengthening relationships that extended beyond the scope of the Challenge.

Some organisations interviewed also viewed the Challenge as a valuable bridge between large organisations and SMEs, enabling the two groups to collaborate more effectively despite differences in priorities and development timelines. Large organisations acknowledged that during the Demonstration Phase (2022-2025), these internal differences contributed to delays in project timelines and increased costs, highlighting the need for improved alignment in

operational speeds among partners. However, the Challenge played a key role in fostering open and constructive communication channels, which enabled consortia to focus on leveraging their complementary strengths rather than viewing these differences as barriers to progress.

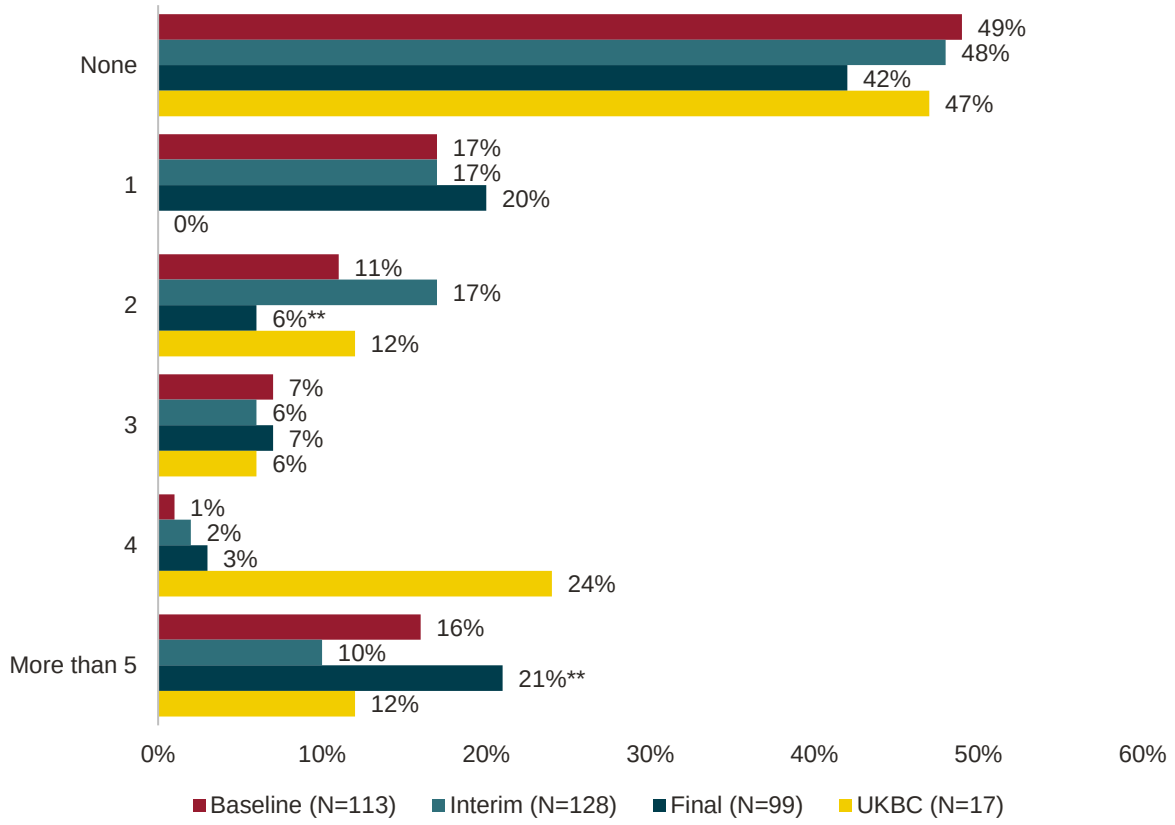
Additionally, the Challenge's supporting events were recognised as key enablers of dialogue and collaboration, connecting organisations that might otherwise have limited opportunities to engage. Stakeholders noted that this engagement facilitated successful, multifaceted projects delivering innovative solutions across the UK. Large organisations indicated that the most significant benefits were derived from workshops with a clear and focused objective, such as those addressing future flight skills. These workshops were recognised as having a tangible outcome, fostering a sense of accomplishment and progression. This, in turn, contributed to increased motivation and commitment to the future flight "common vision", reinforcing engagement and alignment with the sector's goals.

Notably, some SMEs interviewed valued the connections with local government organisations that had been facilitated by the Challenge, which had increased awareness of their projects at the local level. These interactions also highlighted the local benefits of future flight initiatives, fostering stronger ties between the sector and communities, and ensuring that projects aligned more closely with regional needs and priorities.

Trends in international collaboration

The FFC expected that future flight events organised collaboratively with Innovate UK and UKBC would serve as a platform to showcase UK expertise to the international future flight community and to inform international companies and investors about innovations and business opportunities in the UK. Figure 12 highlights the extent of international collaboration within the future flight sector. Respondents from the final survey were significantly more likely to have collaborated with five or more international aviation or future flight companies compared to those from the interim survey (21% vs. 10%). However, a substantial proportion of respondents (42%) reported no collaboration with international companies, while 20% indicated they had collaborated with just one non-UK-based organisation. This suggests that, while international collaboration has increased among some respondents, a significant share of organisations remain focused on domestic partnerships.

Figure 12 Scope of collaboration outside of the UK



Source: *Industry Survey. E2. Number of businesses within aviation/future flight companies collaborating with based outside the UK.*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

According to consortia stakeholders interviewed, the Challenge played a key role in promoting funded projects by facilitating their presence at known international events such as DroneX and the Farnborough International Airshow (FIA). According to stakeholders, this exposure provided valuable opportunities to showcase their innovations, leading to follow-up discussions and potential avenues for securing private funding from international investors, especially for SMEs.

Stakeholders agreed that the Challenge provided a platform to showcase innovative technologies applicable to various use cases while gaining visibility on the global stage. Through its investment and networking opportunities, some SME representatives reported that their technology demonstrations had attracted interest from international industry partners and governments. In certain instances, project collaborators had transitioned from match funders to clients, creating new funding streams and enabling organisations to move closer to achieving in-service operations.

Non-UK organisations interviewed expressed a strong interest in sharing their technologies and expertise within the UK market, driven by the collaborative environment fostered through

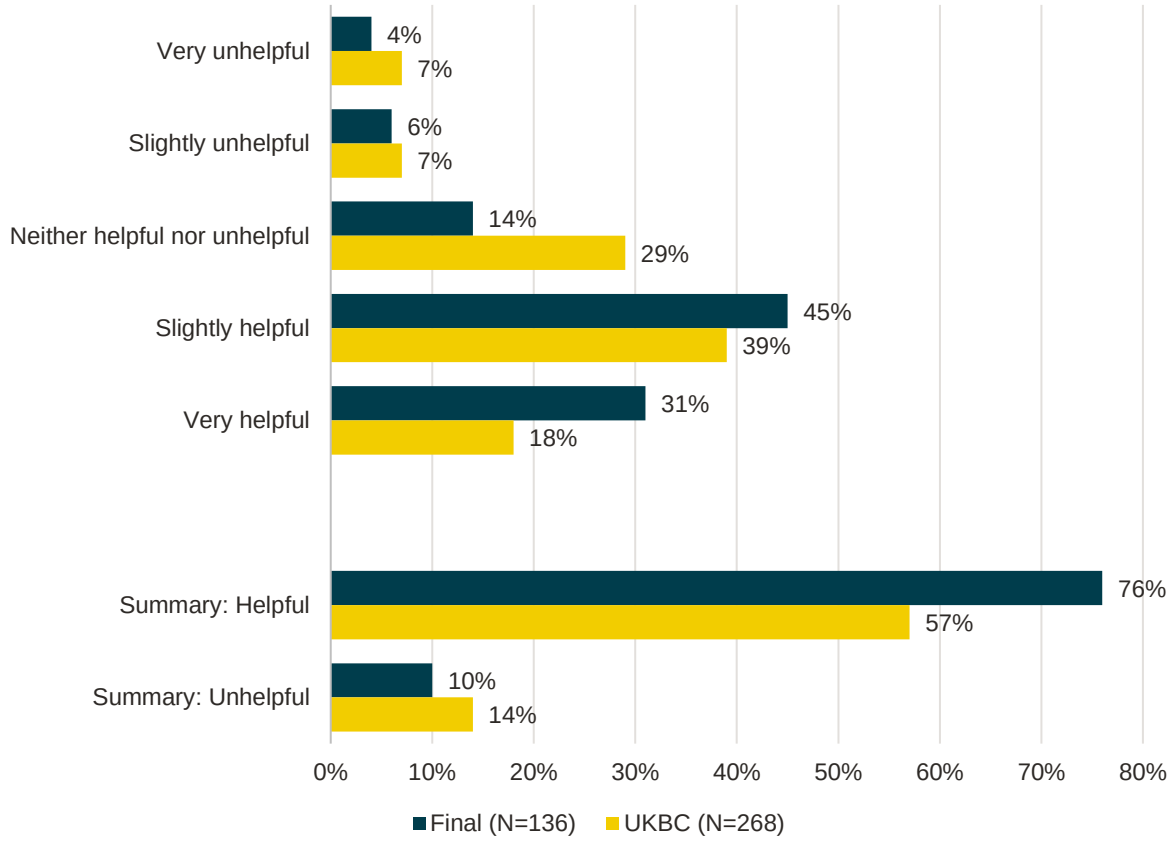
the Challenge. However, many found the restrictions and costs associated with establishing operations in the UK to be prohibitively challenging. Additionally, the benefits of UK funding and collaboration were often outweighed by the larger incentives and funding opportunities available in Europe (i.e., Horizon Europe), which offer significantly greater support for organisations based within European countries. These stakeholders indicated that the relative limitations on flight operations in the UK compared to Europe had further influenced some organisations to relocate their headquarters to European countries, enabling them to increase flight operations and expand their overall company size.

Impact of the FFC on knowledge sharing

The FFC supports the future flight sector through publishing material such as roadmaps, case studies, landscape maps, and public dialogue aimed at keeping organisations better informed about sector developments.[14] As shown in Figure 13, three-quarters (76%) of final survey respondents found FFC publications helpful, while 10% considered them unhelpful, and 14% were neutral. Among those who found the publications helpful, 31% described them as “very helpful”, with this proportion rising to 40% among respondents whose Challenge applications had been accepted. This highlights the role of FFC publications in effectively informing and engaging stakeholders, particularly those directly involved in winning consortia.

[14] Complete list of publications can be found in Annex C.

Figure 13 Extent to which FFC publications were helpful in keeping sector informed of opportunities

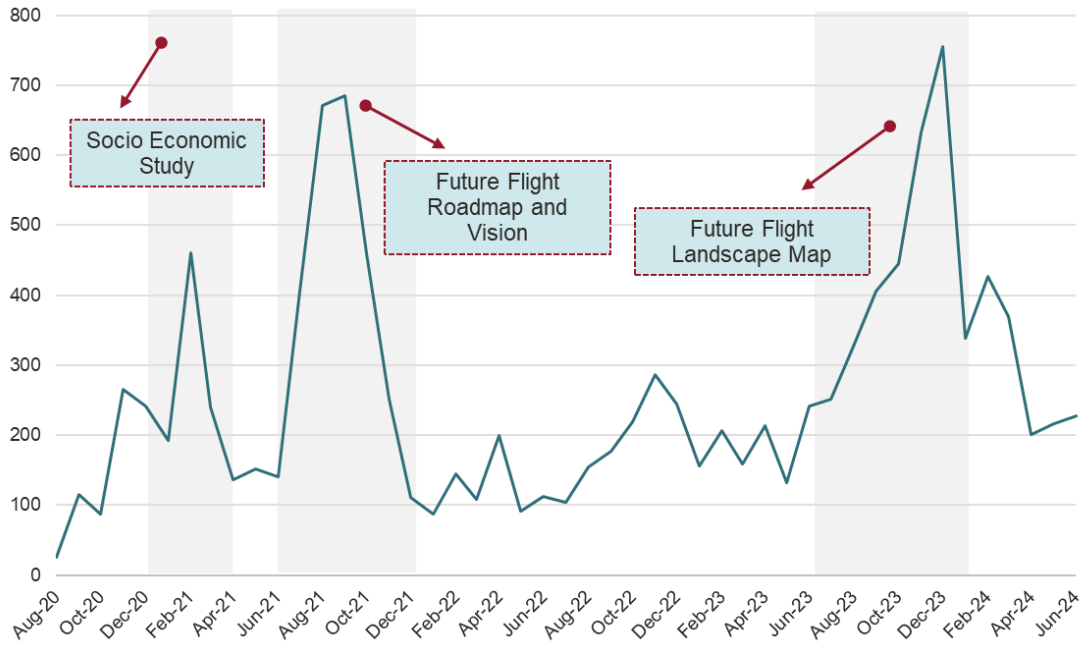


Source: *Industry Survey. B16. How useful were the FFC publications (roadmap, case studies, landscape map, public dialogue) in keeping future flight companies better informed about opportunities in the sector both in the UK and abroad?*

Note: *Base: valid responses.*

Monitoring data from UKBC provides further evidence about the engagement of the future flight community with FFC's published material. Figure 14 shows the number of views of the FFC website over time, highlighting significant peaks in activity that align with the publication of core documents developed by the Challenge. Notable increases in views occurred in February 2021, August 2021, and December 2023, coinciding with the release of the Socio-Economy Study (see Section 3.7), the Future Flight Vision and Roadmap, and the Future Flight Landscape Map, respectively. This evidence suggests that that the publication of these key documents drew significant interest and engagement from stakeholders, demonstrating their importance in shaping the narrative and providing direction for the future flight sector.

Figure 14 UKBC Future Flight Challenge - Number of views



Source: *UKBC website activity data*
Note: *View counts relies on users having accepted cookies so actual values may be higher.*

3.4 Theme 3 – Has the Civil Aviation Authority developed a set of robust regulatory frameworks to support the future flight sector?

3.4.1 Overview

To assess this evaluation theme, we analysed the metrics summarised in Table 10.

Table 10 Theme 3. Regulation – Evaluation metrics

Subtheme	Metric	Data source
Access to the CAA's expertise and guidance	Stated impact of the FFC on the efficiency of the CAA approval process	Survey data, Case studies
Usefulness of CAA non-regulation outputs to industry (e.g., guidance documents)	Stated impact of FFC in usefulness of CAA publications in supporting future flight organisations	Survey data, Case studies

Subtheme	Metric	Data source
Trends in perceptions of regulation as a barrier or enabler; comparison with other jurisdictions	Extent to which the regulation of future flight technologies is a barrier or an enabler	Survey data, case studies
	UK performance in regulation of future flight technologies	Survey data, case studies
Regulatory adoption	Future flight companies operating under future flight-related CAA regulatory frameworks, or frameworks developed since 2019	Case studies
UK regulatory performance compared to other jurisdictions	Jurisdictions adopting components of CAA regulatory framework or seeking guidance from UK regulators	Case studies

Source: Frontier Economics

Theme 3 – Key messages on regulation

- The regulatory development of the future flight sector in the UK has progressed notably over the past few years, especially in areas like BVLOS operations.
- The FFC has played a pivotal role in accelerating these developments by providing essential funding, facilitating industry-regulator engagement, and supporting the demonstrations of new technologies in controlled environments.
- However, there was a consensus among stakeholders interviewed and organisations surveyed that the pace of regulation in response to technological innovation in the future flight sector is still – and is likely to continue to be – a key barrier.
- Challenges remain – such as the cost and complexity of equipment reliance and low take-up of electronic conspicuity – although the FFC's contributions have been critical in moving the UK's regulatory framework towards greater maturity, compared to the slow progress of previous years.
- Continued government support in terms of actionable plans and commitment towards the development of the sector is crucial to advance the regulatory framework, achieve FFC targets, and keep momentum, which will help maintain the UK's competitive edge in the future flight sector.

3.4.2 Aims and activities

One of the main challenges that motivated the design of the FFC was the lack of suitable regulation in the UK, which hindered economically viable development of future flight technologies, particularly UAS and AAM.[15] At the time of the creation of the FFC, the traditional regulatory compliance and certification system was not suitable for these advanced technologies and struggled to address crucial aspects such as BVLOS operations. While the CAA provided some guidance through its "Future Air Mobility Regulatory Sandbox" and "Innovation Hub" services, a need was identified for new regulatory guidance and operating models for upcoming future flight technologies to be operational and able to fly in the UK.

The FFC provided £5 million to the CAA to accelerate the regulatory readiness of future flight technologies in the UK over the duration of the programme. This funding aimed to enhance the capacity of the CAA's Innovation Team to support Development (2021-2022) and Demonstration Phase (2022-2025) projects by establishing points of contact for competition winners, ensuring regulatory planning to facilitate live demonstrations, and accelerating the development of new guidance and regulation.

The Challenge also partially funded a three-year review of the existing legal framework for integrating highly automated systems into the aviation sector, commissioned by the CAA and conducted by the Law Commission. Additionally, the CAA sits on the Advisory Group and FFC Programme Board and is part of the Future Aviation Industry Working Group on Airspace Integration (FAIWG:AI) working alongside the FFC, DfT, CPC and industry stakeholders to gather expert input to inform policy and regulation, with a focus on promoting an integrated airspace.

In 2024, the FFC provided £1.9 million to the British Standards Institute (BSI) to identify gaps in current standards relating to next-generation aviation technologies, and develop new ones as required. This has been an additional part of its work around regulation.

BSI's Future Flight Standards Programme

The BSI is leading an FFC-funded programme to "support safe trials, demonstrations and industrialisation of new classes of air vehicles through standards".[16] As part of this programme, the BSI and the FFC set out four outputs:

- **Flex 1903 Vocabulary**: This document creates a lexicon of standard terms and acronyms used within the future flight sector, which supplements existing vocabularies.
- **BSI Flex 1904 Operational Design Domain (ODD) Taxonomy for Future Flight Consultation**: This document introduces an ODD taxonomy for automated, semi-autonomous, and remotely piloted systems in the future flight ecosystem.

15 UKRI (2023) Future Flight Challenge: interim and process evaluation and Future Flight Challenge Business Case.

16 BSI Future Flight Programme

- **PAS 1905 Future flight systems – Regulatory principles, management systems and life cycle assurance processes – Guidance:** A guide outlining key regulatory aviation principles, management systems, and lifecycle assurance processes, highlighting existing regulations and standards for UAS, remotely operated aircraft systems (RPAS) and AAM aircraft, currently under consultation.
- **Flex 1906 SORA Guidance:** This will provide acceptable means of compliance for UAS operations, with consultation expected in March 2025 in coordination with the CAA.

In addition to these outputs, BSI's programme has published an interactive standards landscape tool that includes information on over 200 standards across a variety of categories such as UAS, AAM, and digital technologies.

At its inception, the FFC anticipated that new regulatory frameworks in the UK for UAS, AAM, and regional hybrid aircraft would be available by 2023, with a goal of opening the airspace to allow BVLOS RPAS operations by 2024.[17] These new frameworks were also expected to contribute to international standards, facilitating cross-country alignment led by the UK. It was assumed that, in the absence of FFC funding, the CAA would continue developing future flight regulatory frameworks but at a slower pace.

During the Development (2021-2022) and Demonstration Phases (2022-2025) of the FFC, the CAA engaged with competition winners to help them understand the regulatory challenges they might face in conducting their proposed demonstrations. This was needed because the projects involved technologies for which there is no existing or appropriate regulation in the UK (e.g., definition of detect-and-avoid policy concept for BVLOS RPAS). As part of the Demonstration Phase, the CAA worked closely with consortia to identify their safety risks and mitigation strategies to assure a safe demonstration of their technologies. Even though developing regulatory frameworks was not one of the intended outputs of most funded projects, it was expected that this engagement with the industry would allow the CAA to identify gaps in current regulation and develop new and more suitable regulation and guidance to ensure the demonstration of future flight technologies.

Between 2023 and 2024, 12 BVLOS projects funded by the FFC were chosen by CAA for controlled trials under its new Temporary Reserve Areas scheme, which temporarily reserves segments of airspace to safely test and evaluate BVLOS operations in the UK. The projects span various applications, including medical drone deliveries, infrastructure inspections, remote policing, and flights to remote locations.

In 2023, the interim evaluation of the FFC identified delayed development of regulatory frameworks and limited progress toward airspace integration as key barriers to advancing future flight technologies in the UK. Many stakeholders interviewed at the time pointed to CAA capacity constraints due to the Covid-19 pandemic and Brexit transition, and the inherent complexity of developing these frameworks for diverse use cases as key factors contributing to these barriers. However, it was recognised that the pace of regulation in response to

[17] UKRI (2022) Future Flight Challenge: Evaluation Framework (reviewed).

innovation in the future flight sector has historically been a challenge as timeframes for developing new regulation are normally longer than the pace of technological development.

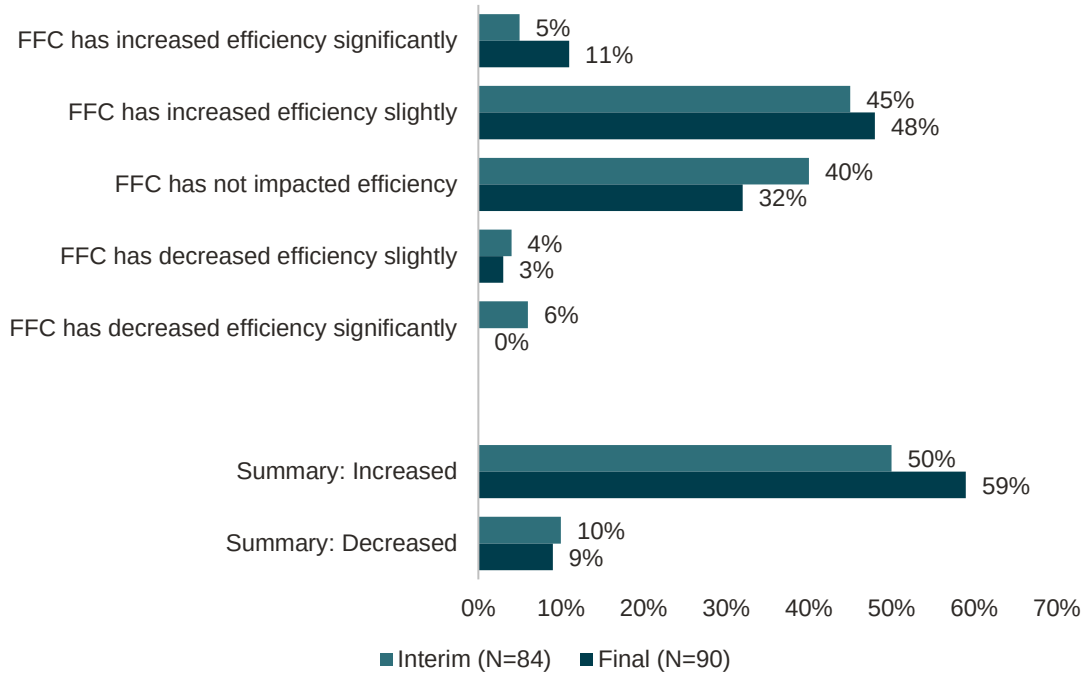
Results from the industry survey that supported the interim evaluation also indicated that the UK's regulatory performance had declined relative to other countries between the baseline assessment in 2021 and the interim evaluation in 2023. However, at the time of the interim evaluation, certain regulatory developments were underway but had not yet been published and therefore could not be included in the assessment. In addition, the interim evaluation gathered only limited evidence on the FFC's role in influencing either standards or international regulation.

3.4.3 Evaluation evidence

Effect on the efficiency of the CAA approval process for demonstrations

Interim and final survey respondents were asked to assess whether the FFC had improved the efficiency of the CAA demonstration approval process for FFC-funded consortia. Figure 15 shows that views among those surveyed were somewhat positive. In the final survey, a majority of organisations (59%) believed the FFC had contributed to improving the efficiency of the approval process. However, 32% of respondents felt the FFC had had no impact on efficiency, suggesting room for further improvements in streamlining approvals. Notably, though, there was a small increase in the share of respondents who felt the FFC's impact had been positive, from 50% in the interim evaluation to 59% in the final evaluation, albeit that this was not a statistically significant increase.

Figure 15 Impact of the FFC on the efficiency of the CAA approval process for FFC-funded consortia



Source: *Industry Survey. C4C. How much do you think the FFC has improved the efficiency of the CAA's demonstration approval process for FFC-funded consortia?*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

In the interim evaluation, stakeholders interviewed identified the primary bottleneck in demonstration approvals to be a lack of CAA capacity, flexibility, and innovation. By the final evaluation, several stakeholders noted that, while progress had been made, the CAA still faced significant resource constraints, limiting its ability to respond promptly to industry needs. This situation created a gap in regulatory responsiveness, raising concerns about the UK's ability to keep pace with international advancements.

> *"After Brexit, we found the CAA quite severely under-resourced…did not have enough capability and capacity to be able to develop regulation at pace." – Industry stakeholder*

> *"In the past few years, we have dealt with the consequences of Brexit, which significantly hindered CAA's capacity to develop regulation as quickly as other countries." – Regulation stakeholder*

Despite these concerns, there have been notable positive developments. In particular, in 2024, the CAA received additional resources from the DfT to implement the Future Flight Action Plan.[18] Stakeholders interviewed viewed the establishment of the FAIWG:AI working group as

[18] DfT (2024) Future Flight Action Plan

a positive development, as it brought together various parties to collaboratively develop this plan. The document outlines a shared vision with specific milestones and deliverables, including achieving demonstrations of BVLOS operations in non-segregated airspace by 2025 and autonomous eVTOL flights by 2030. A central statement of intent within the plan is to "rapidly develop a policy framework and regulatory environment that enables trials and innovation, effectively charting a safe path from demonstration to full-scale implementation." The FFC is identified as a pivotal enabler of this vision, playing a critical role in bringing sector players together to jointly develop the “system of systems”.

> *“The regulatory landscape in the UK is improving quite significantly because the CAA efforts and CAA resources in the future flight sector are improving and increasing.” – Industry stakeholder*

Effect on usefulness of CAA publications

Industry stakeholders interviewed recognised that the regulatory landscape in the UK, particularly for BVLOS operations, has evolved significantly compared to previous years, and that there is now more clarity on the long-term position of the regulation. In 2023, the CAA updated its Airspace Modernisation Strategy[19] and placed a strong focus on transitioning from a segregated airspace to an integrated system that accommodates all users, including emerging vehicles like BVLOS. The CAA is also moving forward with the development of key policies and ongoing testing and consultation on critical topics related to electronic conspicuity, unmanned traffic management, and detect-and-avoid systems.

Indeed, in the last two years, the CAA has published a series of civil aviation publications including policy guidance documents, innovation cases studies, examples of concepts of operations (ConOps), research, and consultations on pieces of regulation that are directly related to FFC objectives. For example, the CAA has launched a consultation on its proposed policy concept[20] for the assurance of detect-and-avoid systems to mitigate mid-air collision risk,[21] one of the biggest barriers for the safe integration of BVLOS operations, and it has published two policy concepts on Atypical Air Environments and Temporary Reserve Areas to help enable BVLOS operations.[22]

To better understand respondents’ perspectives on the usefulness of CAA publications in supporting future flight organisations to meet regulations and standards, new questions were added to the final evaluation survey. These publications include CAA guidance documents, reports, and other civil aviation publications. As shown in Figure 16, the majority of final survey respondents (64%) and UKBC respondents (70%) found CAA publications to be useful. Notably, successful consortia were significantly more likely than average to perceive CAA

19 CAA (2023) Airspace Modernisation Strategy

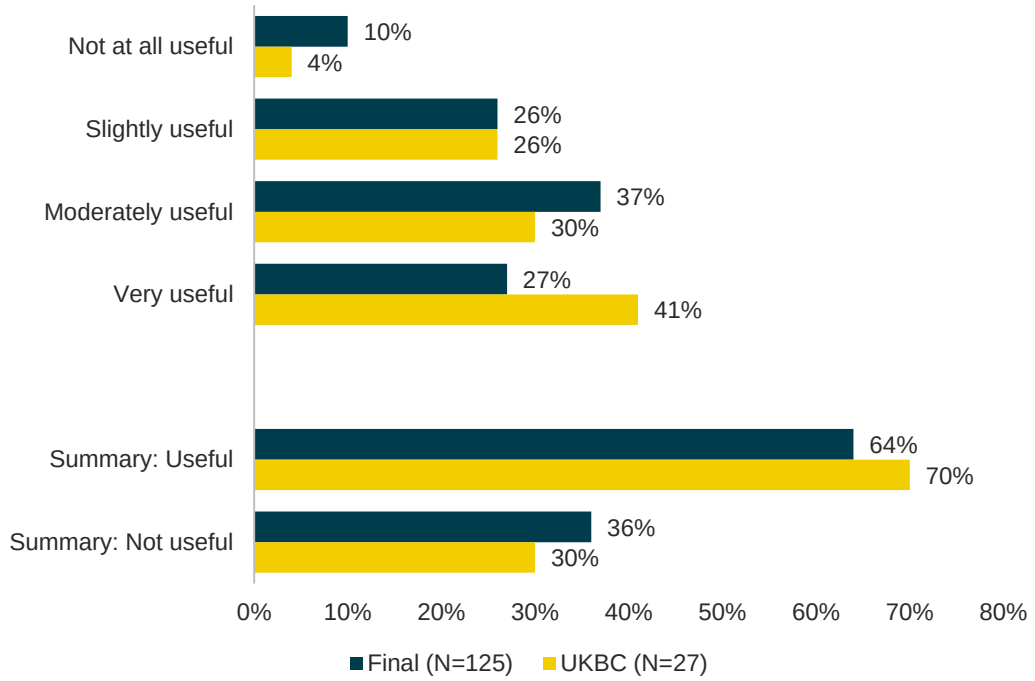
20 A policy concept is a preliminary framework or proposal outlining potential regulatory approaches to emerging aviation technologies and operations.

21 CAA (2024) Detect and Avoid Policy Concept Consultation (still under review)

22 CAP3040: Unmanned Aircraft Operations in an Atypical Air Environment: Policy Concept

publications as helpful, with 83% indicating they supported future flight organisations in meeting regulatory requirements.

Figure 16 Extent to which CAA publications are useful in supporting future flight organisations

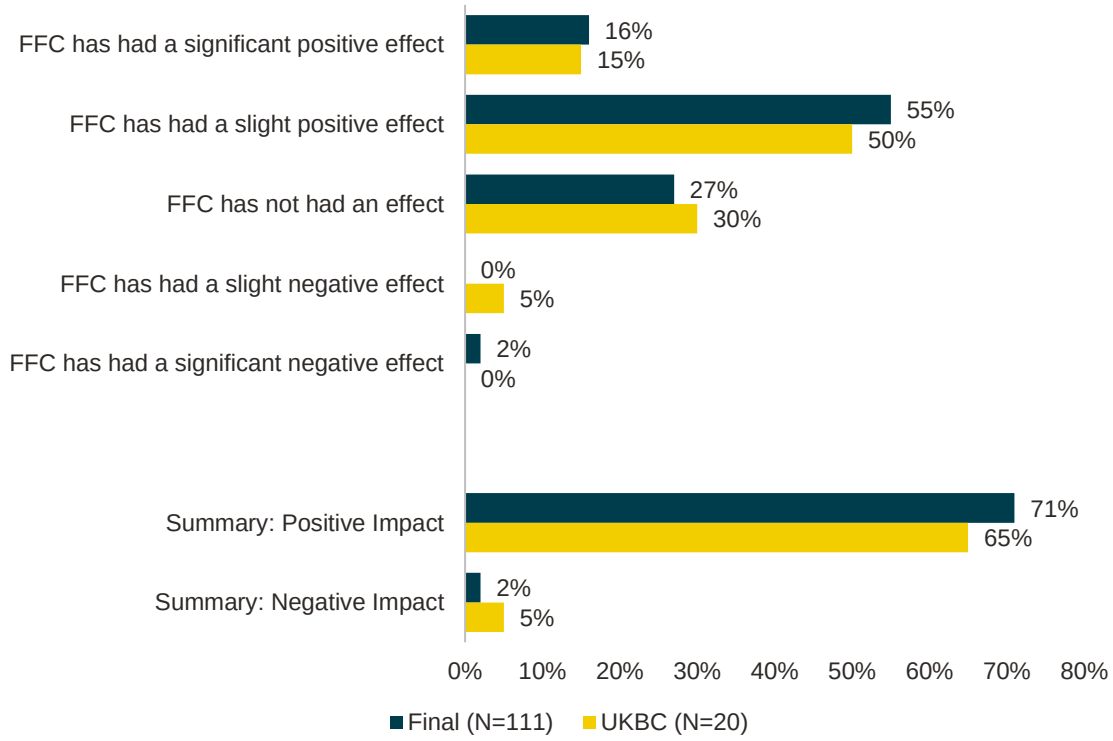


Source: *Industry Survey. C4G/2 Currently, how useful are the below in supporting future flight organisations to meet regulations and standards?: (CAA guidance documents, reports and other civil aviation publications (CAP).*

Note: *Base: valid responses.*

Final survey respondents were also asked whether they believed the FFC had influenced the usefulness of CAA publications in supporting future flight organisations. As indicated in Figure 17, a majority of respondents (71% of consortia members and 65% of UKBC respondents) stated that the FFC had had a positive impact on these publications, enhancing their role in helping organisations meet regulations and standards. Only a small minority (2%) of final survey respondents felt the FFC had had a negative effect, while over a quarter (27%) believed it had had no impact at all. These findings highlight the generally favourable perception of the FFC's role in improving regulatory resources, although a notable proportion felt its influence was limited.

Figure 17 Impact of FFC in usefulness of CAA publications in supporting future flight organisations



Source: *Industry Survey. C4H/2 What impact, if any, do you think the FFC has had in the usefulness of these sources in supporting future flight organisations to meet regulations and standards?: (CAA guidance documents, reports and other civil aviation publications (CAP).*

Note: *Base: valid responses.*

While a few of the CAA's new publications and policy concepts, such as the guidance on Carriage of Dangerous Goods by RPAS,[23] can be directly linked to specific projects funded by the FFC, attributing all recent CAA developments solely to the FFC is challenging. Stakeholders interviewed recognised that these advancements were possible largely due to the additional resources the CAA had received in recent years to focus on regulatory innovation for the future flight sector. This is line with the interim evaluation, which found that the FFC funding had allowed the CAA to secure capacity and accomplish substantially more innovation work than would have been possible without it.

> *"The CAA has been working more closely with the industry, which has helped us create a common action plan that outlines objectives for the future." – Industry stakeholder*

A critical development was also the closer collaboration between the CAA and industry. Before the Challenge was launched, the future flight industry had limited avenues to interact with the regulator. Stakeholders highlighted that the funding provided by the FFC to the CAA was essential for facilitating interaction and engagement with the industry. By providing funding

[23] CAP 2248: Carriage of Dangerous Goods by Remotely Piloted Aircraft Systems

and support to various CAA Sandbox projects, the FFC has enabled operators to work with the CAA in shaping future regulations while testing their own technologies under regulatory oversight. This collaboration has also provided the regulator with valuable resources for policy testing, allowing it to gain insights into industry challenges and real-world implications of new technologies, which, in turn, has helped refine current and new regulatory frameworks.

> *"If FFC was not funding those industries, I am not sure we would have had that engagement with the industry. It has been very useful to develop policies and understand what the industry is thinking. For example, in the development and testing of the policy of detect and avoid." – Regulator*

Stakeholders also recognised the work that the BSI and CAA are doing in developing the UK Specific Operations Risk Assessment (UK SORA) which will provide a framework to systematically assess the risk associated with UAS operations based on a set of quantitative safety targets and appropriate operational procedures.[24] UK SORA was seen by some stakeholders as the most flexible framework to assess risks to different types of UAS operations within the "specific category" (i.e., flying operations with a greater level of risk than basic flying such as BVLOS or dropping items from drones), which could give UK operators an advantage compared to other jurisdictions. The UK SORA is still under consultation but is expected to come into force in 2025 and it will replace the current Operating Safety Case approach for UAS.

> *"UK SORA is a big achievement because at the moment I think this is the most flexible way to allow all kind of operations in the specific category." – Regulator*

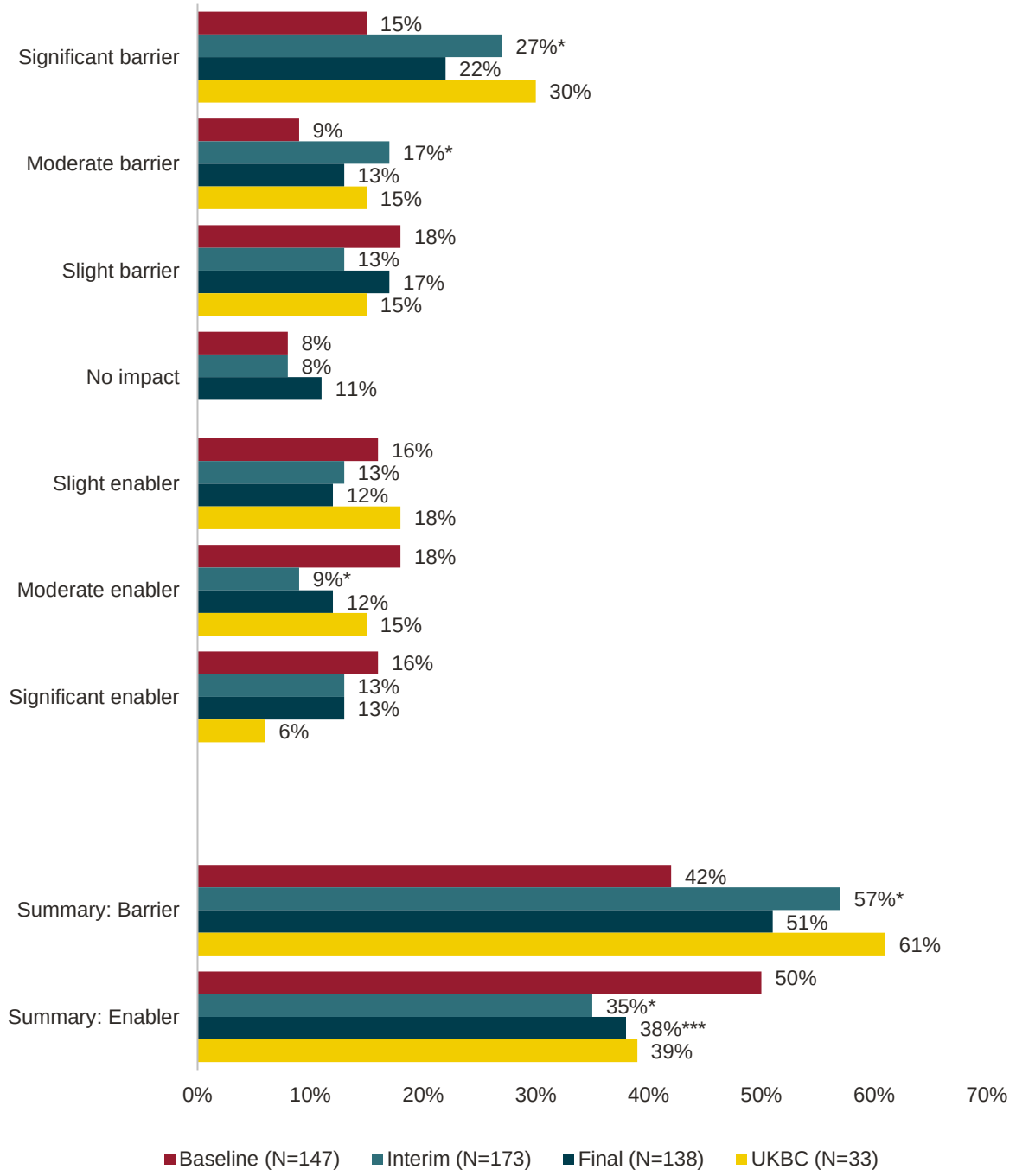
Trends in perceptions of regulatory readiness for technological development

Figure 18 presents respondents' perceptions of whether the regulation of future flight technologies acts as a barrier to or an enabler of the sector's progression in the UK. In the final survey, nearly two-fifths (38%) of respondents viewed regulation as an enabler, marking a significant decline from 50% in the baseline survey but a slight (if insignificant) uptick from the 35% who viewed regulation as an enabler at the interim evaluation. Conversely, around half (51%) of final survey respondents considered regulation to be a barrier to technological progress, which represents a slight improvement from the interim evaluation.

Among UKBC respondents, the perception of regulation as a barrier was even more pronounced, with 61% identifying it as a barrier and 39% viewing it as an enabler. Notably, respondents whose applications to the Challenge had been accepted were significantly more likely to perceive regulation as an enabler compared to those whose applications had been rejected (48% vs. 35%). This disparity suggests that direct involvement with the Challenge may positively influence perceptions of regulatory frameworks.

[24] Proposal to adopt the UK Specific Operations Risk Assessment (UK SORA) as AMC to UK Regulation (EU) 2019/947

Figure 18 Extent to which the regulation of future flight technologies is a barrier or an enabler



Source: *Industry Survey. C5/4. For each of the following, please indicate whether you think they are a barrier or enabler to the progression of future flight technology in the UK: Regulation of future flight technologies.*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

This trend may be linked to the increased technological maturity of systems and technologies used by respondents between the baseline and final surveys. Evidence from case studies shows that, as the industry matures and the demand for future flight operations grows, there is increasing pressure for regulatory frameworks to evolve to facilitate commercial growth, and for regulators to develop clearer and more flexible guidance. In the UK, this is particularly evident in the case of BVLOS operations, where there is growing demand for applications in logistics, infrastructure inspection, customer deliveries, and emergency services. In contrast, demand for other future flight technologies – such as eVTOL or hybrid-electric aircrafts – remains limited, and therefore regulation in these areas has been slower.

Overall, there is a consensus among stakeholders that regulation remains a significant barrier to both technology demonstrations and the transition to in-service operations. While there has been progress, the development of regulation and standards is still a work in progress as the CAA works towards its long-term objective of an integrated airspace. Policy concepts are only being implemented on a trial basis in controlled environments, with the aim of eventually developing clear guidance and compliance paths for operators and inspectors.

> *"We are much in a testing space that can hopefully form up the acceptable means of complying with the regulation…while we are actively looking for test cases to demonstrate and generate evidence, it might not have gone as far or as fast as everyone hoped." – Regulator*

Stakeholders interviewed recognised that, while technological development is occurring quickly, the development of regulation often lags behind due to the need for thorough risk assessments, stakeholder consultations, and the establishment of safety standards.

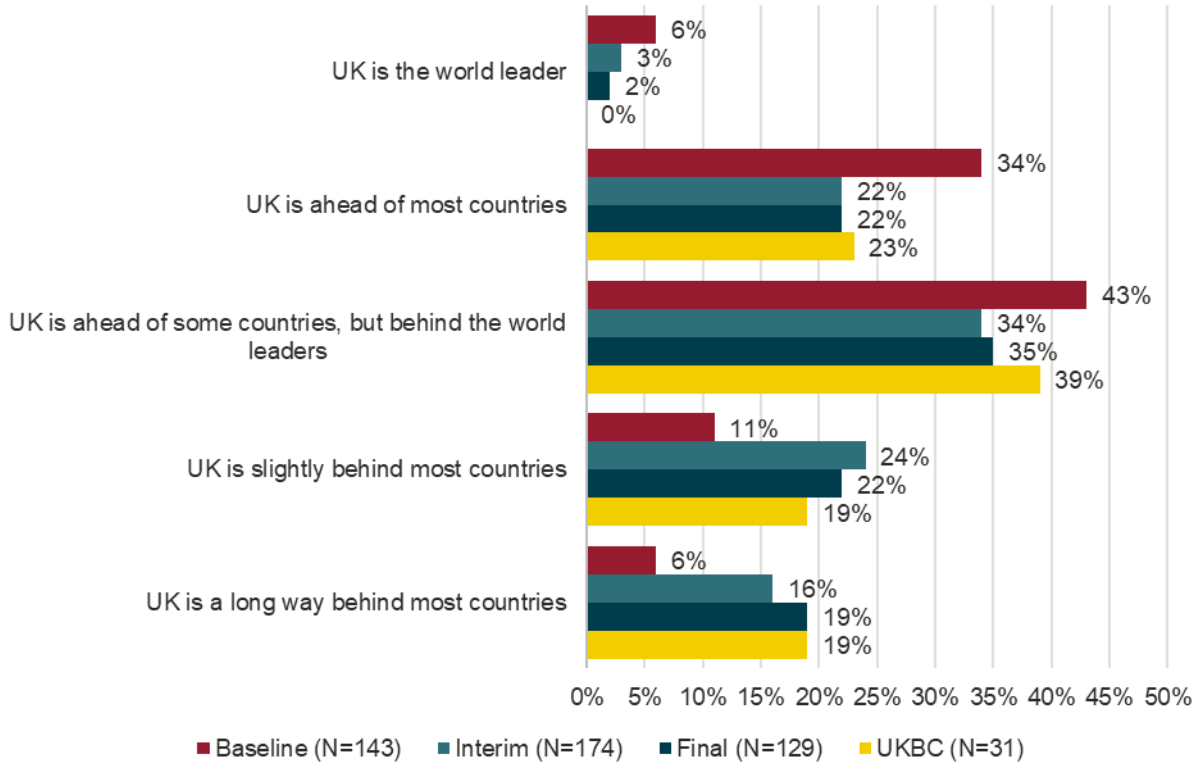
Industry stakeholders also noted that regulation may not be the primary obstacle for SMEs. Even if regulatory barriers (e.g., approvals, risk management processes, and airspace management systems) were addressed, many SMEs interviewed indicated they would still face challenges in transitioning to scalable in-service operations due to other constraints. In particular, for the sector to evolve from demonstrations to scalable in-service operations, a substantial level of investment is necessary.

Figure 19 shows respondents' views on the UK's current performance in regulating future flight technologies compared to other countries. A quarter (24%) of final survey respondents believed that the UK was a world leader or ahead of most countries in this area, a figure consistent with the interim survey (25%) but significantly lower than the 40% recorded in the baseline survey. Conversely, the proportion of respondents who believed the UK was behind most countries grew, reaching 41% in the final survey, similar to 40% in the interim survey but significantly higher than the 17% reported at baseline.

UKBC respondents shared similar perspectives, with 23% considering the UK a world leader in future flight regulation, while 38% felt the UK was lagging behind most other countries. Respondents with a mix of accepted and rejected FFC applications were more likely to view the UK as being behind (45%) compared to those with only accepted applications (27%). Similarly, service providers in the sector were more likely than average to express that the UK

was falling behind, with 51% sharing this view. These findings highlight growing concerns about the UK's competitive standing in regulatory innovation for future flight technologies.

Figure 19 UK relative performance in regulation of future flight technologies



Source: *Industry Survey. C1/4. I'm now going to read out some elements of future flight technology development and support. For each, please can you tell me how you think the UK is currently performing in comparison to other countries?: Regulation of future flight technologies.*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Unlike traditional aviation, which benefits from established and stable regulatory frameworks, the future flight sector operates in a rapidly evolving landscape with emerging technologies like BVLOS drones and eVTOLs that often lack clear or well-defined regulations. Service providers depend heavily on regulatory advancements to enable operations, and delays or inefficiencies in these areas can directly impact their ability to scale.

Stakeholders consulted as part of the case studies agreed that the UK faces regulatory challenges similar to those in Europe and other countries. These include public acceptance, airspace integration, and the need for a comprehensive regulatory framework that accommodates new technologies while ensuring safety. These challenges have led most regulators to remain cautious and hesitant to implement bold regulatory changes without broad consensus and a solid foundation of supporting evidence gathered over years.

However, some stakeholders recognised that the UK faces unique challenges in adopting future flight technologies due to its busy and complex airspace, with densely populated areas,

stricter low-flying regulations, and limited adoption of electronic conspicuity devices among general aviation. This makes the integration of BVLOS operations more challenging compared to countries like the US, Australia, Canada, the UAE, and China, where less congested or more flexible airspace policies facilitate these operations.

> *"The UK is a small, busy country, and while there are quieter areas in the highlands, the market is not as focused there." – Regulator*

Despite these challenges, the UK is recognised as making progress in the regulatory space, particularly in enabling BVLOS operations, and the CAA is regarded as a technically capable regulator. Some stakeholders recognised that the UK's engagement with international regulatory bodies has also increased significantly in the last two years as the CAA has taken a leading role in international working groups like the International Civil Aviation Organization and the Joint Authorities for Rulemaking on Unmanned Systems (JARUS), sharing its expertise and best practices in air risk assessment and mitigation strategies with other national aviation authorities and the European Union Aviation Safety Agency (EASA).

> *"Clearly there was a change in direction, a change in priorities that affected the JARUS work, the UK CAA has really increased interest, and they are in fact leading these efforts (updating risk management framework for UAS operations – SORA)." – Regulator*

Regulatory adoption

Stakeholders interviewed identified factors that affect both the pace of regulatory development and its future compliance. These include the development of safety standards and supporting infrastructure and reliable equipment such as vertiports, air traffic management systems, and electronic conspicuity devices.

For example, while detect-and-avoid policy concepts are being developed and tested, one stakeholder mentioned that a key challenge is related to equipment reliance, especially for smaller operators, because developing and certifying equipment is costly and complex. Smaller drone companies need to develop their own equipment and systems for BVLOS operations in house, compared to the more traditional manned aviation industry, which relies on certified manufacturers.

> *"Reliance on equipment is expensive. A lot of equipment does not even exist…the supply chain for the RPAS industry nowhere near as mature as it is for the large aircraft businesses." – Regulator*

Stakeholders noted that standards are essential for reducing industry costs and supporting regulators in approving new operations by streamlining authorisation procedures. While many standards exist or are under development worldwide, they are primarily tailored to larger, manned aircrafts.

Industry stakeholders emphasised the critical need for clear, universally accepted standards to facilitate smoother operations, ensure compliance for equipment manufacturers, and ultimately support the safe demonstration and scaling of industry activities. This requires the

CAA to align more closely with international regulators, particularly EASA and the Federal Aviation Administration (FAA), to foster mutual recognition of certifications. Industry stakeholders saw this alignment as essential to supporting UK exports, enabling international operations for UK-based companies, and facilitating market entry for foreign companies wishing to operate in the UK.

> *"I am not sure there is a lot of advantage in leading, if we end up with a different set of criteria to everyone else because that does make it quite difficult to work with other countries…it places administrative burdens." – Regulator*

3.5 Theme 4 – Has the Challenge increased investment and R&D in future flight technologies?

3.5.1 Overview

To assess this evaluation theme, we analysed the metrics summarised in Table 11.

Table 11 Theme 4. Investment and R&D – Evaluation metrics

Subtheme	Metric	Data source
Trends in perceptions of future flight investment in the UK	Extent to which private/public sector investment is a barrier or an enabler	Survey data, case studies
	UK relative performance in terms of private/public sector investment compared to other jurisdictions	Survey data
	Stated impact of FFC on ease of securing investment for the development of future flight technologies	Survey data
	Future access to public grants or private investment as a result of engagement with the FFC	Survey data
R&D spending	Value of R&D spending (GBP) before and after competitions	Survey data
	Stated impact of FFC on R&D spending	Survey data

Subtheme	Metric	Data source
Extent to which opportunities for public and private funding have grown over time	Value of industry match funding (co-investment estimates)	Co-investment Survey data
	Value of public sector investment in future flight companies	Gateway to Research
	Value of funding secured by future flight companies	Crunchbase, case studies
	Impact of FFC on the ease of securing investment for the development of future flight technology	Survey data
	Stated impact of FFC on securing public grants or private investment	Survey data

Source: Frontier Economics

Theme 4 – Key messages on investment and R&D

- The Challenge has exceeded its objective to leverage £175 million of industry co-investment by 24%, with £217 million realised as of February 2025.
- The FFC is seen as instrumental in helping organisations secure both public and private funding and in facilitating future investment opportunities, particularly for successful consortia. Nearly half of survey respondents reported increased R&D spending due to their engagement with the FFC, with the majority indicating this was new funding.
- Crunchbase data shows that successful companies began to attract significantly more funding compared to non-successful companies and the rest of the sector. Notable peaks were observed in 2021 and 2024 driven by two successful firms.
- Data from the Gateway to Research portal highlights a large increase in the number and value of future flight R&D studies between 2019 and 2023, reflecting growing public sector support for the sector.
- However, survey data reveals a growing perception of private sector investment as a barrier and a decline in respondents viewing public sector investment as an enabler, compared to the interim and baseline surveys. The UK's relative position compared to international competitors is also perceived to have declined relative to the baseline and interim evaluation. These trends appear to be tied to broader external factors.
- Stakeholders noted that larger funding pools and testing capabilities in countries like the US and EU may have diverted potential investment away from the UK, making it more difficult to secure private sector funding.

- Key uncertainties include the availability of long-term investment mechanisms after the FFC concludes, particularly for SMEs, and the ability to demonstrate routine operations to build confidence and attract private investment.

3.5.2 Aims and activities

R&D underinvestment among private companies is a widely recognised market failure across many industries, often driven by the spillover benefits of R&D that other companies can capitalise on and the inherent uncertainty around the potential returns on investment. In the future flight sector, this challenge is further exacerbated by a disconnect between the research conducted by the academic community and businesses' ability to commercialise this research, translating it into viable products and services for the market.[25]

While the UK aerospace sector has historically benefited from substantial R&D investment led by a handful of major companies, the level of investment varies significantly depending on the specific future flight technology and company size. Smaller firms, in particular, often face greater barriers to investing in R&D due to limited resources, while emerging technologies may struggle to secure consistent funding despite their long-term potential to transform the sector. Addressing these disparities is critical to fostering innovation and ensuring the UK remains competitive in the rapidly evolving future flight ecosystem.

One of the main objectives of the FFC is to boost business investment and R&D spending within the future flight sector, including attracting investment that might otherwise have gone to other jurisdictions. At its inception, the FFC anticipated an increase in the number of R&D projects and demonstrations between 2021 and 2025 by enabling marginal projects to become viable and accelerating R&D efforts that might otherwise have been delayed. Ultimately, the intention was that funded projects would help stakeholders identify investment opportunities, enhance the global profile of the UK future flight sector, and improve its competitiveness to unlock further public and private funding.

In the absence of the FFC, it was anticipated that investment in future flight technologies would have grown organically but only at a rate consistent with general sector growth. Such investment would likely have been limited to projects where expected private returns exceeded costs or where alternative sources of public funding were available. It was expected that, without the accelerated momentum and strategic focus provided by the FFC, the sector's development would have progressed at a slower and less coordinated pace.

To help achieve this objective, the FFC required winning consortia to match competition grants during the Development (2021-2022) and Demonstration Phases (2022-2025).[26] The FFC measures this co-investment through various metrics, as outlined in Table 12. To estimate

[25] Future Flight Challenge Business Case.

[26] Match-funding requirements ranged from 50-75% for large organisations, 40-65% for medium-sized organisations, and 30-55% for micro or small organisations, depending on the type of project (industrial research or experimental development).

realised co-investment, the Challenge collected data from consortia via surveys conducted in June 2021, March 2022, December 2022, September 2024, and February 2025. However, it is important to note that these figures may not fully represent incremental investment in the future flight sector or specific technologies, as some of the reported funding may have occurred independently of FFC support.

At its inception, the FFC set a target of £175 million in total co-investment. However, due to higher than expected accompanying and aligned co-investment figures, the FFC has already exceeded this target. As of February 2025 (based on the latest annual Co-Investment Survey), a total of £217 million of co-investment had been recorded, 24% above target. With the FFC set to conclude in March 2025, this figure is expected to rise further.

Table 12 FFC co-investment estimates

Type	Description	Realised investment (million) 2023-2025
Pledged co-investment	Investment that consortia plan to spend on the FFC project	£44
Accompanying co-investment	Extra public (non-UKRI) and non-public investment in R&D over and above the pledged co-investment that contributes to achieving project objectives	£95
Aligned co-investment	Investment in technologies or R&D projects aligned to and prompted by the FFC-funded project	£31
Follow-on co-investment	Investment in bringing to market or exploiting outcomes from FFC-funded projects (often combined with other intellectual property to achieve commercial projects)	£47
	Total	**£217**

Source: The pledged co-investment estimate is based on FFC's internal monitoring, while other figures are derived from FFC estimates using co-investment surveys conducted in June 2021, March 2022, December 2022, September 2024, and February 2025, supplemented by secondary sources such as Beauhurst due to a low response rate.

Note: These estimates include both private and public investments.

As part of the interim evaluation in 2023, the FFC portfolio review identified several channels through which competition project outputs were expected to drive private investment. A key focus of the portfolio was on accelerating the development of new technologies and capabilities relevant to traditional aviation markets, which holds significant potential to attract external investment. However, the review observed that introducing new models of airspace management was a relatively uncommon project objective. Despite its lower prominence, this

objective was recognised as a crucial enabler for the adoption of future flight technologies and a key driver of future investment within the sector.

Results from the industry survey that informed the interim evaluation indicated that organisations generally held positive views on private and public funding. However, these views were slightly less positive compared to the baseline, reflecting concerns that the UK may have lost some international competitiveness in attracting investment opportunities since the Challenge's inception. Key uncertainties highlighted during the interim evaluation included the availability of public funding mechanisms after the conclusion of the FFC, limited access to European initiatives, and the UK's ability to enhance its competitiveness to attract foreign investment in the future flight sector.

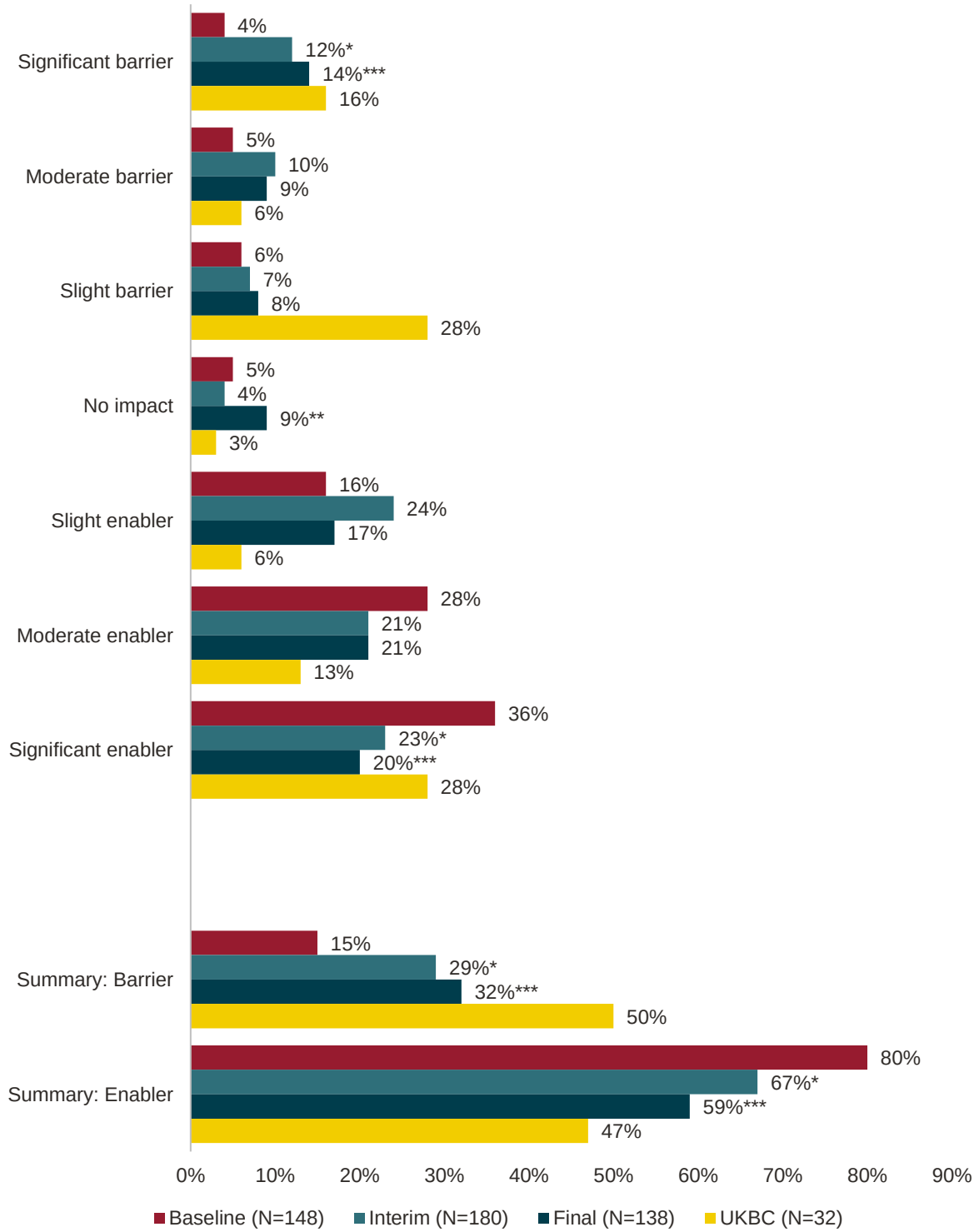
3.5.3 Evaluation evidence

Trends in perceptions of private sector investment

Figure 20 shows survey respondents' perceptions of private sector investment as either a barrier to or an enabler of the progression of future flight technology in the UK. In the final evaluation survey, 59% of respondents viewed private sector investment as an enabler, marking a significant decline from the 80% reported in the baseline survey. Conversely, the proportion of respondents who regarded private sector investment as a barrier increased to 32% in the final survey, compared with 15% in the baseline. Changes between the interim and final evaluations were smaller but also showed a small decline in perception, with the share of respondents perceiving private investment to be a barrier increasing from 29% to 32%.

Respondents whose applications to the Challenge had been accepted were significantly more likely than average to describe private sector investment as an enabler (77%), whereas those whose applications had been rejected were more likely than average to consider it a barrier (40%). Among UKBC respondents, opinions were more evenly divided, with 47% identifying private sector investment as an enabler and 50% describing it as a barrier.

Figure 20 Extent to which private sector investment is a barrier or an enabler

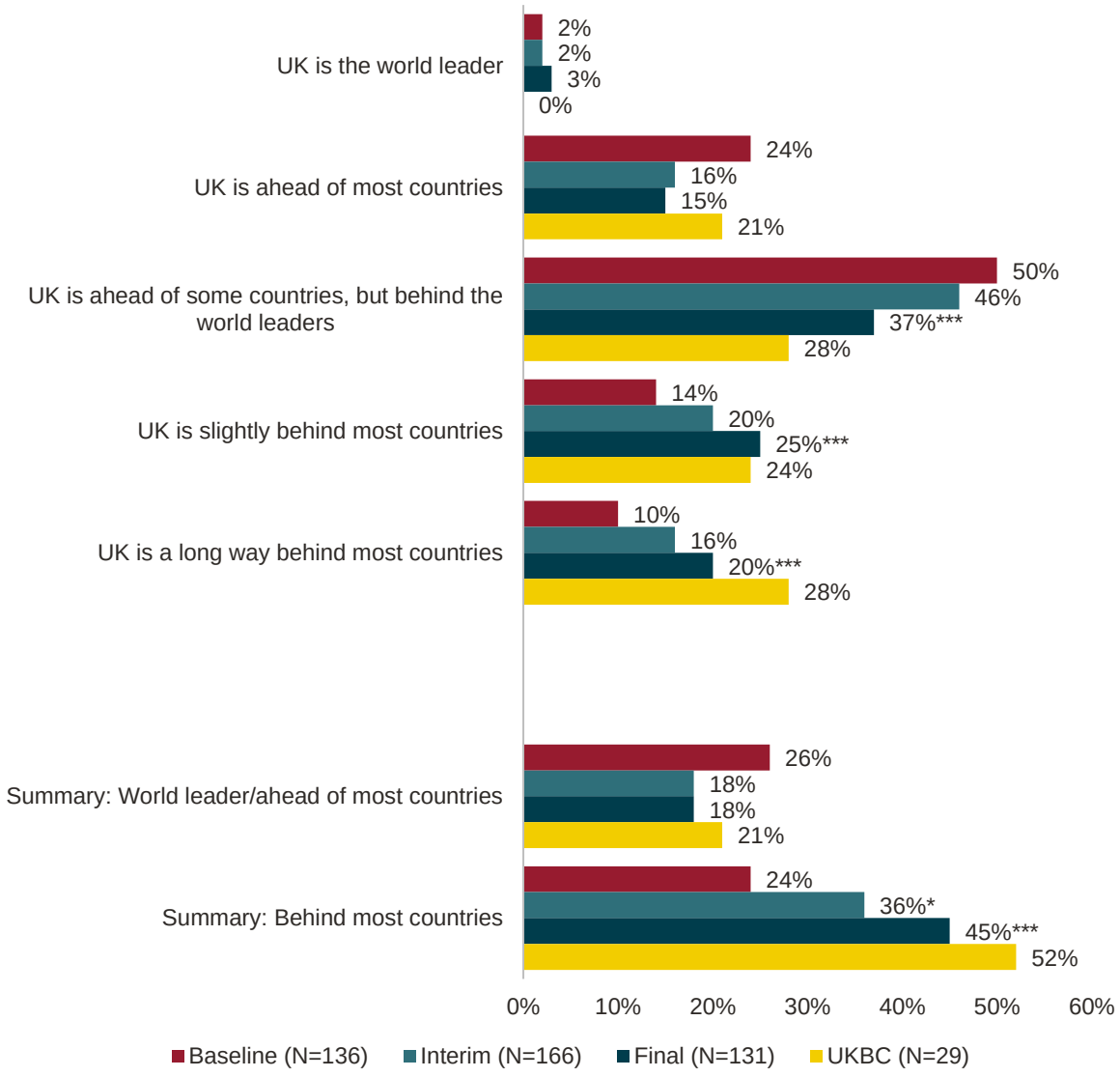


Source: *Industry Survey. C5/1. For each of the following, please indicate whether you think they are a barrier or enabler to the progression of future flight technology in the UK: Private sector investment for the future flight sector.*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Figure 21 presents perceptions of the UK's performance in attracting private sector investment for the future flight sector relative to other jurisdictions. In the final survey, 18% of respondents identified the UK as a world leader or ahead of most countries in this area. However, the proportion of respondents who believed the UK was lagging behind most countries increased significantly, rising to 45% in the final survey compared to 24% at the baseline and 36% in the interim evaluation. These findings highlight growing concerns about the UK's competitive position in securing private sector investment for the future flight sector.

Figure 21 UK performance in terms of private sector investment for the future flight sector



Source: *Industry Survey. C1/1. I'm now going to read out some elements of future flight technology development and support. For each, please can you tell me how you think the UK is currently performing in comparison to other countries?: Private sector investment for the future flight sector.*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Based on evidence from the case studies, the decline in perceived private investment opportunities in the UK future flight sector can be attributed to several factors tied to broader trends in the UK aerospace industry. Economic uncertainty, arising from the ongoing effects of Brexit, global supply chain disruptions, and inflation, has created a less favourable investment environment (see Section 3.1).

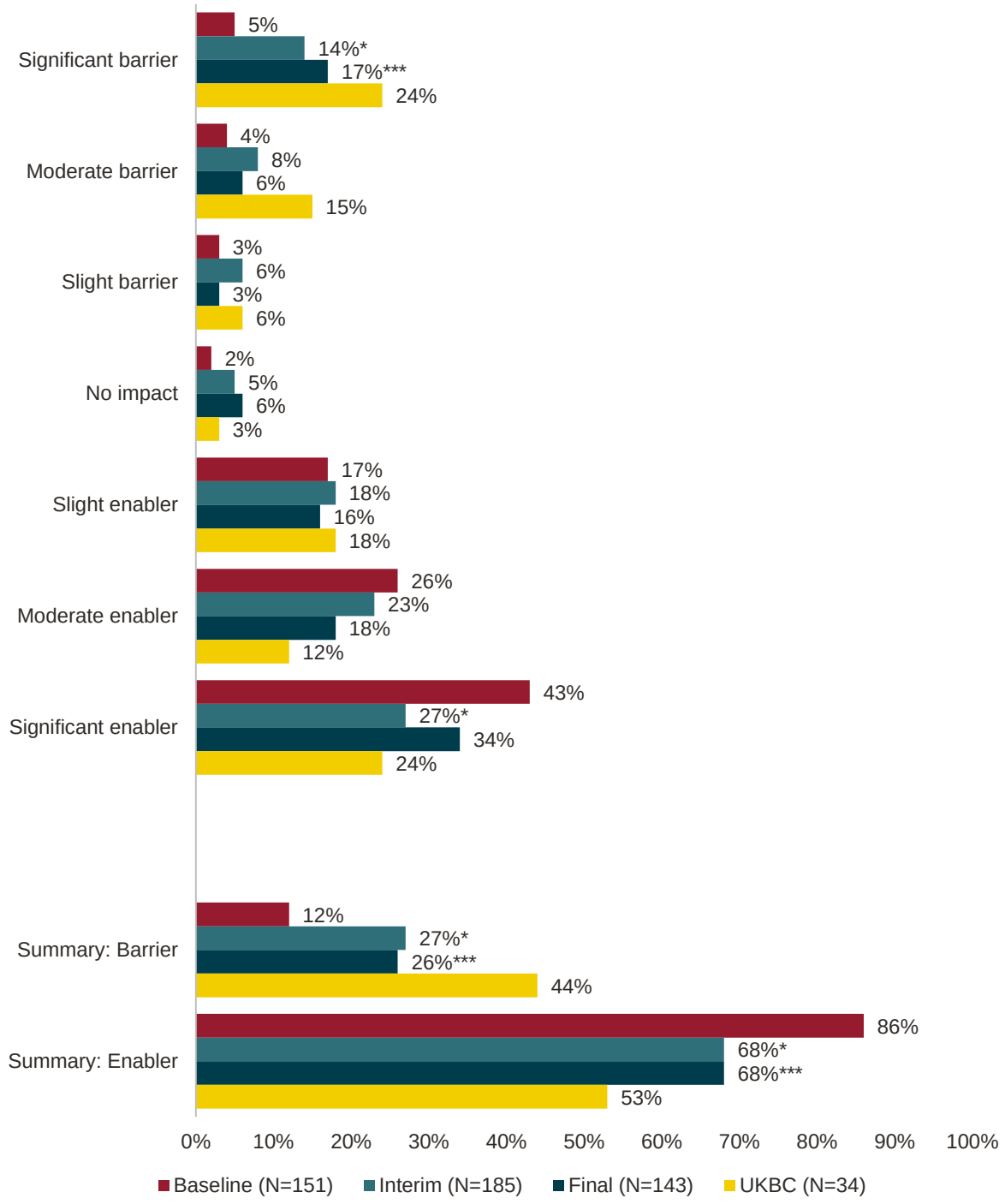
Additionally, interviewees highlighted that the UK faces obstacles in maintaining its competitive edge, as other jurisdictions, including the US, Canada, Australia, China, and European Union countries, benefit from larger funding pools, more established markets, greater adoption of electronic conspicuity, expansive unoccupied spaces for testing, and limited general aviation activity. These advantages in competing markets may have diverted potential private investors away from the UK, making it more challenging to attract and retain investment in the sector.

Large organisations interviewed agreed that private sector investment is essential to unlocking the potential of the future flight sector. With the sector expected to be closer to in-service operations following the Demonstration Phase, they noted that making a case for future government initiatives involving R&D funding would be increasingly challenging. As a result, some organisations highlighted the importance of achieving "groundbreaking wins" and demonstrating routine, business-as-usual operations to build confidence and attract private investment.

Trends in perceptions of public sector investment

Figure 22 illustrates survey respondents' views on whether government funding or investment acts as a barrier to or enabler of the progression of future flight technology in the UK. In the final survey, the majority of respondents (68%) considered government funding or investment as an enabler, consistent with the interim survey but significantly lower than the 86% reported at the baseline. The proportion of respondents who identified government funding or investment as a barrier increased substantially in the final survey, rising to 26% compared to 12% at the baseline, again with little change from the interim evaluation. Respondents with accepted FFC applications were notably more likely to view government funding or investment as enabling technological progress (81%), reflecting the positive impact of direct support on their projects.

Figure 22 Extent to which government funding or investment is a barrier or an enabler

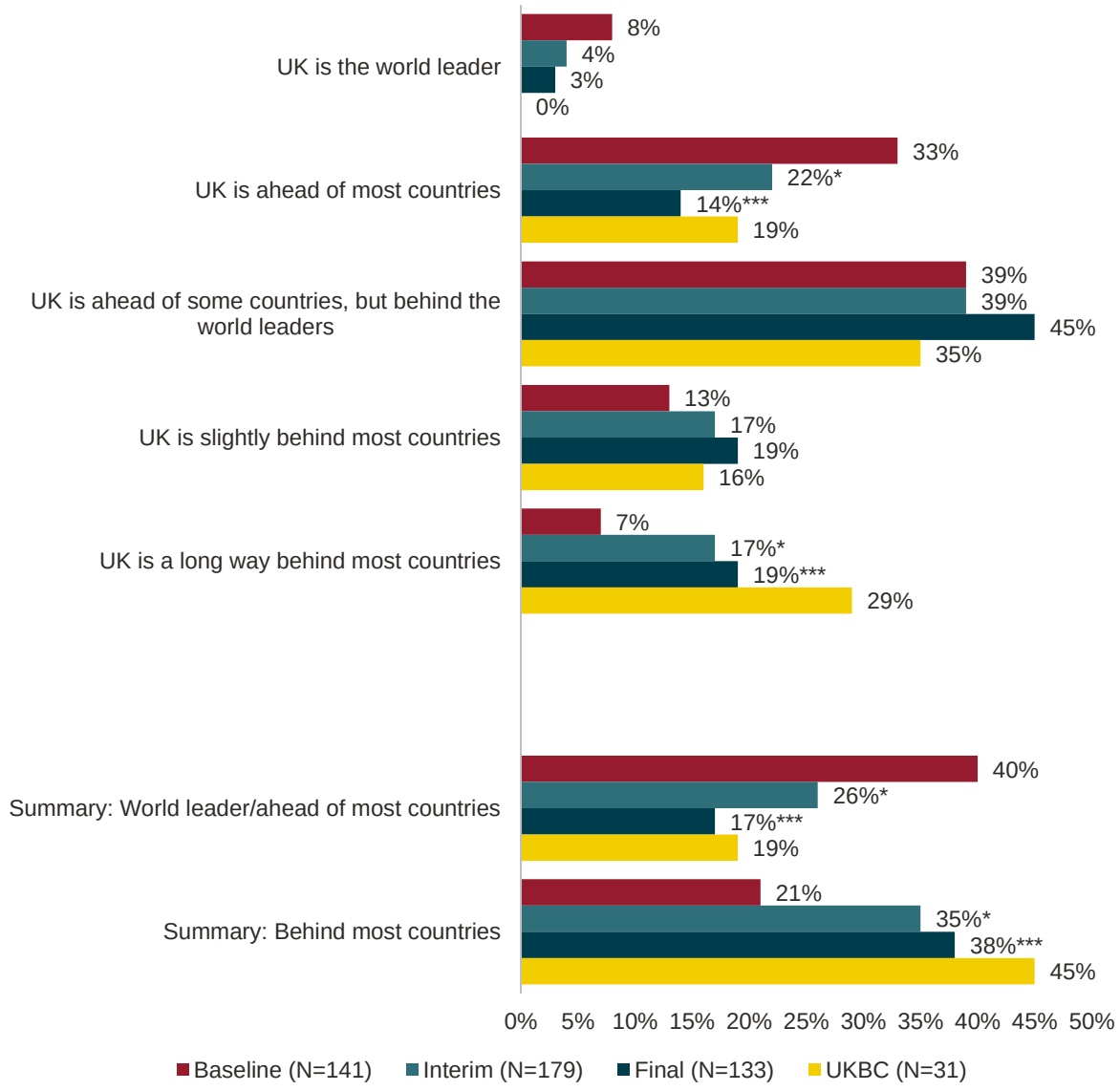


Source: *Industry Survey. C5/2. For each of the following, please indicate whether you think they are a barrier or enabler to the progression of future flight technology in the UK: Government funding or investment.*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Survey respondents were also asked to evaluate the UK's performance in government funding or investment for the future flight sector compared to other countries. As shown in Figure 23, only 17% of final survey respondents believed the UK was a world leader or ahead of most countries, a significant decline from 40% in the baseline survey and a further decline from 26% in the interim evaluation. Conversely, 38% considered the UK to be behind most countries, a notable increase from 21% at baseline although similar to the interim evaluation findings (35%).

Figure 23 UK performance in terms of government funding or investment for the future flight sector



Source: *Industry Survey. C1/2. I'm now going to read out some elements of future flight technology development and support. For each, please can you tell me how you think the UK is currently performing in comparison to other countries?: Government funding or investment.*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Respondents who worked as technology integrators were more optimistic, with 35% indicating that the UK was a world leader in government funding or investment. Technology integrators may view the UK's government funding and investment more positively because they often benefit directly from these initiatives. As central players in projects that require the integration of various systems and technologies, they are likely to participate in government-supported collaborations. Their strategic role in the supply chain and alignment with government priorities for advancing emerging technologies may further reinforce this perception.

There was consensus among stakeholders interviewed that there are currently no public funding mechanisms comparable to the FFC that offer large-scale grants for developing future flight technologies, particularly those that actively involve local authorities and SMEs. As found in the interim evaluation, before the Challenge, businesses, academia, and local authorities could apply to other public funds, but these had been interrupted by external factors such as the Covid-19 pandemic and Brexit.[27] Stakeholders highlighted that the FFC represented a significant step forward in the government's efforts to elevate the profile of the UK future flight sector on the global stage.

> *"Before the Challenge, we struggled to get any traction or funding." – Industry stakeholder (SME)*

The majority of industry stakeholders agreed that the funding provided by the FFC served as a crucial stepping stone for advancing future technologies, although perspectives differed between SMEs and large organisations.

For SMEs, the Challenge's support was transformative, enabling them to establish and expand their capabilities, expertise, and market presence. One SME interviewed credited the Challenge for the majority of its success, while another stated that its organisation might not have existed without the opportunities it provided. Even for those SMEs that had not been successful in the Demonstration Phase, the Challenge offered ongoing benefits through event invitations, enabling them to remain engaged with the future flight community and fostering the exchange of knowledge, insights, and ideas.

Despite these advantages, SMEs interviewed expressed significant concerns regarding their sustainability in the future flight sector, driven by a lack of long-term investment from both public and private sources. Some stakeholders noted that current funding levels were only sufficient to "keep things moving", with any disruption posing risks to their cash flow once the Challenge concludes. According to SMEs interviewed, without addressing these funding gaps, the sector could face a substantial reduction in SME participation within the next years. They emphasised the importance of follow-on funding to drive commercialisation and ensure a stable, economically viable future flight ecosystem.

In contrast, large organisations interviewed reported less reliance on income from the future flight sector compared to SMEs due to their established presence in aerospace and other

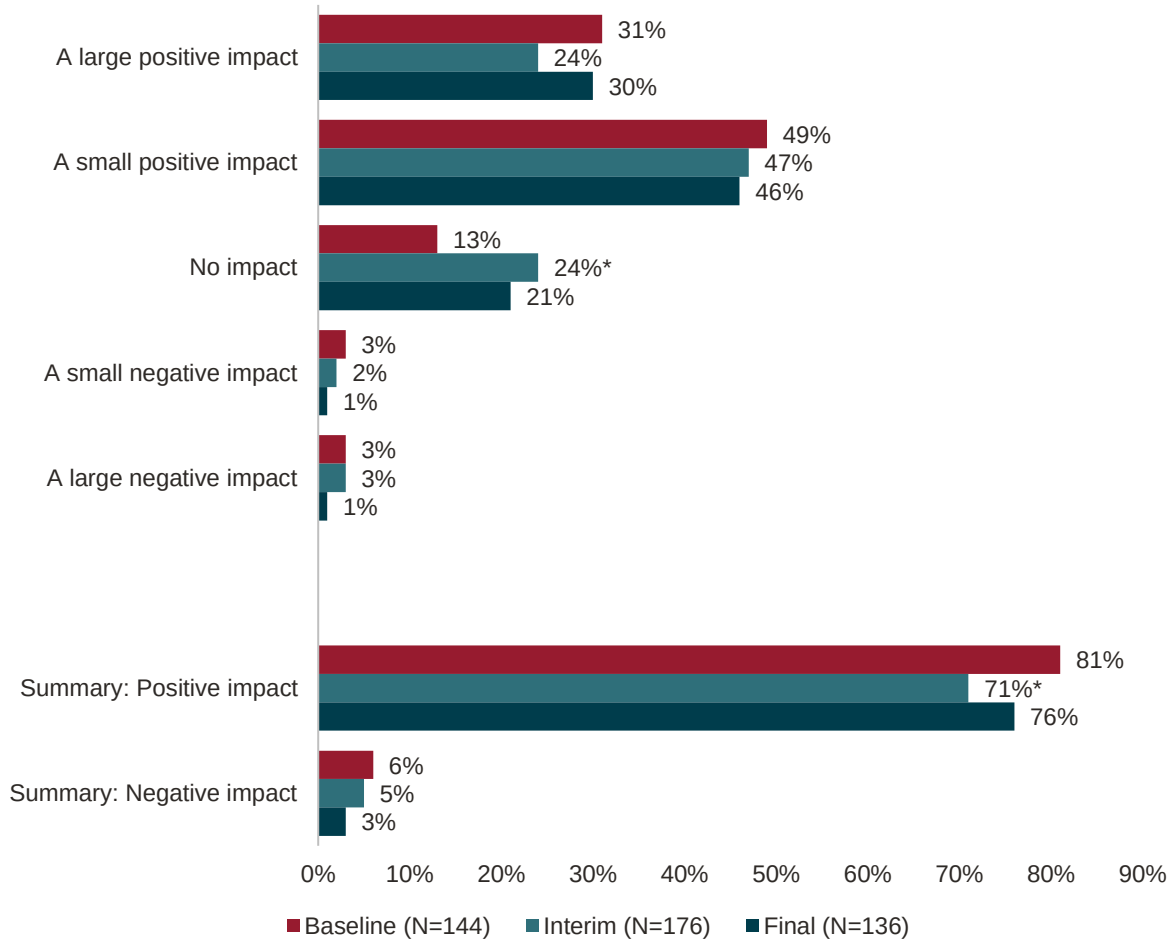
[27] For example, Connected Places Catapult (CPC) Drone Pathfinder Catalyst Programme, Nesta's Flying High Programme, Aerospace Technology Institute's funding for core technologies, Horizon Europe.

industries. Instead, they viewed their involvement as an opportunity to contribute to the sector's growth by providing funding, expertise, and engagement in future flight use cases. While most large organisations interviewed acknowledged that the sector was unlikely to become a major revenue stream for them, they emphasised its value as a platform to explore emerging technologies like drones, which have the potential to improve operational efficiency, enhance safety, and support net zero goals.

Effect of the FFC on ease of securing investment

There is evidence of the FFC's role in enhancing investment opportunities, particularly for successful consortia. Figure 24 presents respondents' perceptions of the FFC's impact on the ease of securing investment for developing future flight technology. Overall, three-quarters (76%) of final survey respondents expressed a positive view of the FFC's impact in this area, with only 3% reporting a negative impact. Respondents with accepted FFC applications were significantly more likely to view the FFC's impact positively, with 84% reporting favourable perceptions. Perceived positive impacts were slightly higher in the final evaluation than the interim, albeit still a little below the baseline perspective.

Figure 24 Impact of FFC on the ease of securing investment for the development of future flight technology



Source: *Industry Survey. C4. What impact, if any, do you think the Future Flight Challenge has had on the ease of securing investment in relation to development of future flight technology?*

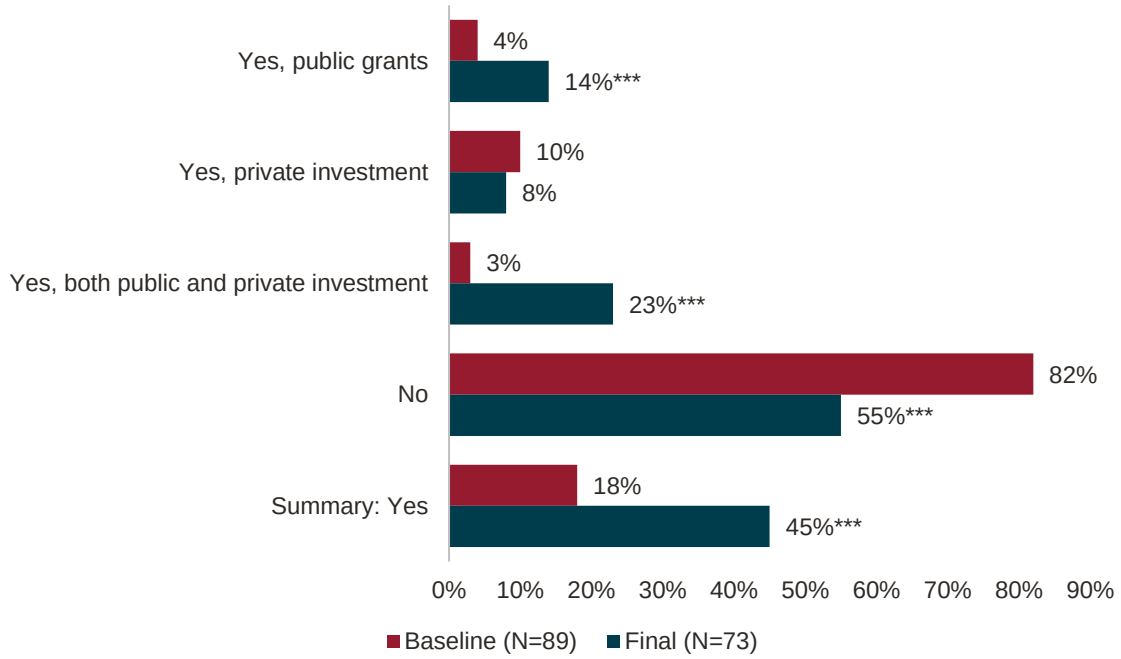
Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Another more tangible way to assess the FFC's contribution to the ease of securing investment relates to the current or future access to public grants or private investment among successful consortia as a result of their engagement in FFC projects. Figure 25 highlights whether respondents in the baseline and final surveys received public grants or private investment as a result of their engagement with the FFC. In the final survey, 45% of respondents reported accessing additional investments due to their FFC involvement, a substantial increase from 18% at baseline.

Respondents in the final survey were also significantly more likely to have received both public and private investment (23% compared to just 3% in the baseline survey). Conversely, baseline respondents were far more likely to report receiving no investments (82% compared

to 55% in the final survey). These findings suggest that the FFC has played an increasingly influential role in facilitating access to both public and private funding over time.

Figure 25 Access to public grants or private investment as a result of engagement with the FFC

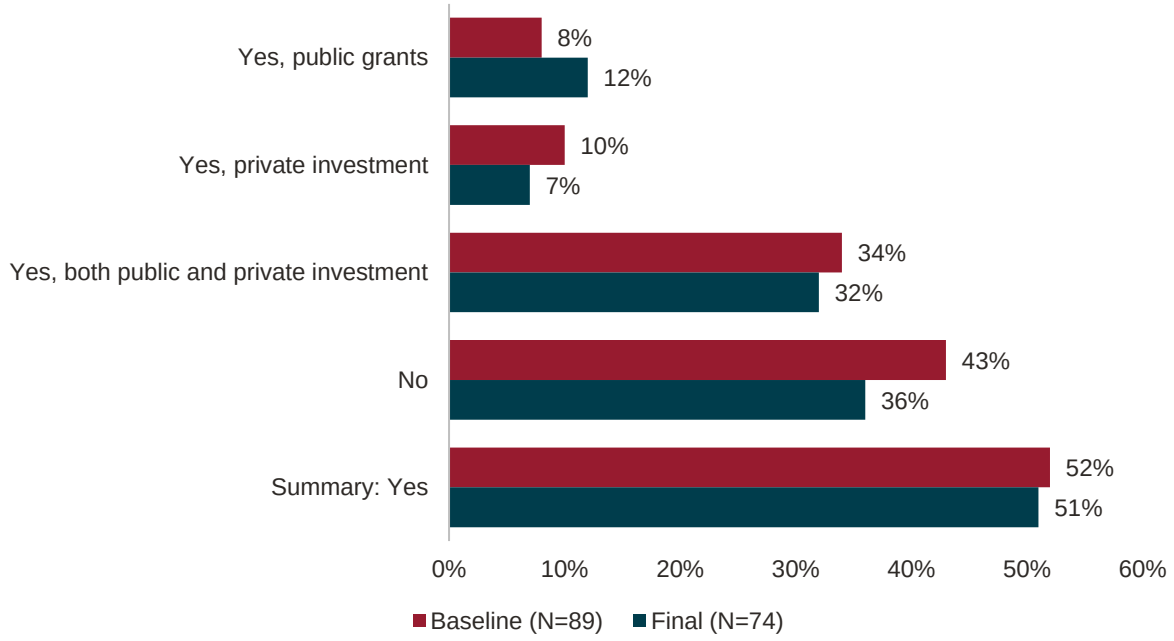


Source: *Industry Survey. D11. Have you received any other public grants or private investment as a result of your engagement with FFC?*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

There was also optimism among successful consortia regarding the FFC's contribution to facilitate further funding opportunities. Respondents were asked whether they anticipated securing additional public grants or private investment due to their engagement with the FFC. As indicated in Figure 26, half (51%) of final survey respondents anticipated securing future investment, a proportion similar to the 52% reported in the baseline survey. Notably, despite the sample consisting largely of organisations that had already secured additional investment, there is no clear indication of a slowdown in the expected profile of future investments.

Figure 26 Future access to public grants or private investment as a result of engagement with the FFC



Source: *Industry Survey. D12. Do you expect to secure any further public grants or private investment as a result of your engagement with FFC?*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Value of private sector investment in future flight companies

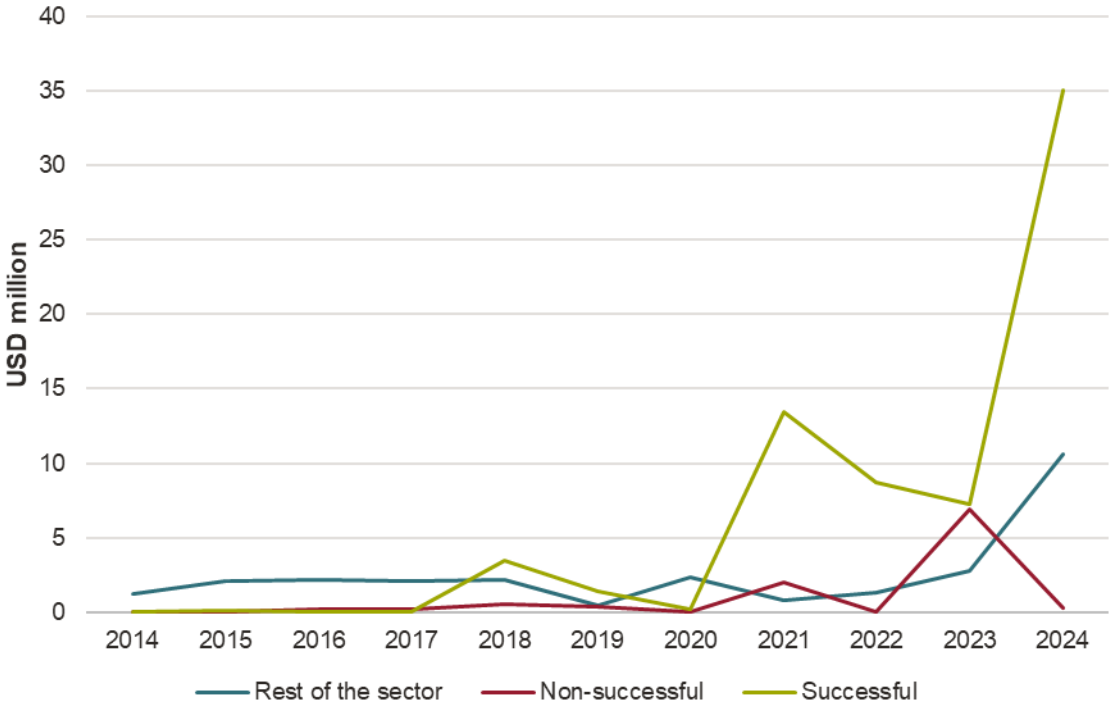
This metric is evaluated using secondary statistical evidence from Crunchbase, a data platform that provides financial and investment information on companies as well as industry trends. Given that Standard Industry Classifications (SICs) lack the granularity to identify emerging and specialised sectors like the future flight sector, companies were identified by searching the platform using a set of keywords detailed in Annex B. The complete list of FFC applicant businesses (successful and non-successful) was linked manually to Crunchbase using its Companies House's registered names.

Crunchbase aggregates data from publicly available sources, user contributions, and partnerships. However, it may not capture all funding rounds, particularly for smaller companies, and its primary focus on tech start-ups and venture-backed firms could limit coverage of other industries. As a result, Figure 27 presents the average funding secured by future flight companies for each type of engagement with the FFC rather than the total funding identified through the platform, providing a more focused view of sector-specific investment activity.

Up until 2020, funding levels remained relatively stable and under $5 million across all groups. From 2021 onwards, successful companies began to attract significantly more funding

compared to non-successful companies and the rest of the sector, with notable peaks in 2021 and 2024, driven by two companies: Vertical Aerospace[28] and Skyports.[29] However, this funding has fluctuated considerably over time. The rest of the sector also shows a positive upward trend in funding starting in 2021, suggesting growing interest and investment in the broader future flight ecosystem.

Figure 27 Average funding per company secured by future flight sector, by type of engagement



Source: *Crunchbase*

Note: *The value is given in nominal USD and excludes mergers and acquisitions. The data was extracted on 12/11/24.*

Value of public sector investment in future flight companies

This metric is evaluated using secondary statistical evidence from the Gateway to Research portal, which provides detailed data on public funding allocated to individual future flight studies. To identify relevant projects, the portal was searched using a list of keywords, presented in Annex B. grouped by future flight technologies. Studies with research titles or abstracts containing at least one keyword were classified as future flight R&D studies. While this provides valuable insights into public sector support for future flight research projects, it

28 "Vertical Aerospace announces $205 million in additional funding led by Mudrick Capital"

29 "Skyports raises in excess of $110M in Series C round led by new investment from ACS"

does not capture a broader view of investment in future flight companies beyond their involvement in these studies. It is worth noting that Gateway to Research captures only a portion of government funding, specifically that delivered through UKRI, which includes the Research Councils and Innovate UK. It does not provide a comprehensive record of funding from other public sources (e.g., government departments).

Table 13 presents the time series of studies on the Gateway to Research portal that involve future flight-related topics. In the five years before the FFC, there were 96 future flight studies listed in the portal, with a total value of £25 million. Both the number of studies and total value of public sector investment allocated to them have increased considerably since the FFC was launched. Indeed, between 2019 and 2023 (last year with complete data), there were 229 future flight studies, receiving a total of £148 million, an increase of almost six times in funding. The average value of the studies in 2023 was over £400,000, although this figure has fluctuated over time without following a clear trend, suggesting variability in the scale and scope of individual research projects.

Table 13 Public sector investment in studies that involve future flight companies

Year	Number of future flight studies	Average value of public sector investment	Total value of public sector investment
2014	11	343,244	3,775,687
2015	9	269,685	2,427,162
2016	21	415,119	6,641,896
2017	31	339,918	6,118,525
2018	24	789,962	6,319,694
2019	21	1,498,757	13,488,809
2020	65	922,205	47,954,652
2021	41	531,284	13,813,374
2022	45	1,623,995	56,839,824
2023	57	409,164	16,366,571
2024	23	417,933	9,194,527

Source: Gateway to Research

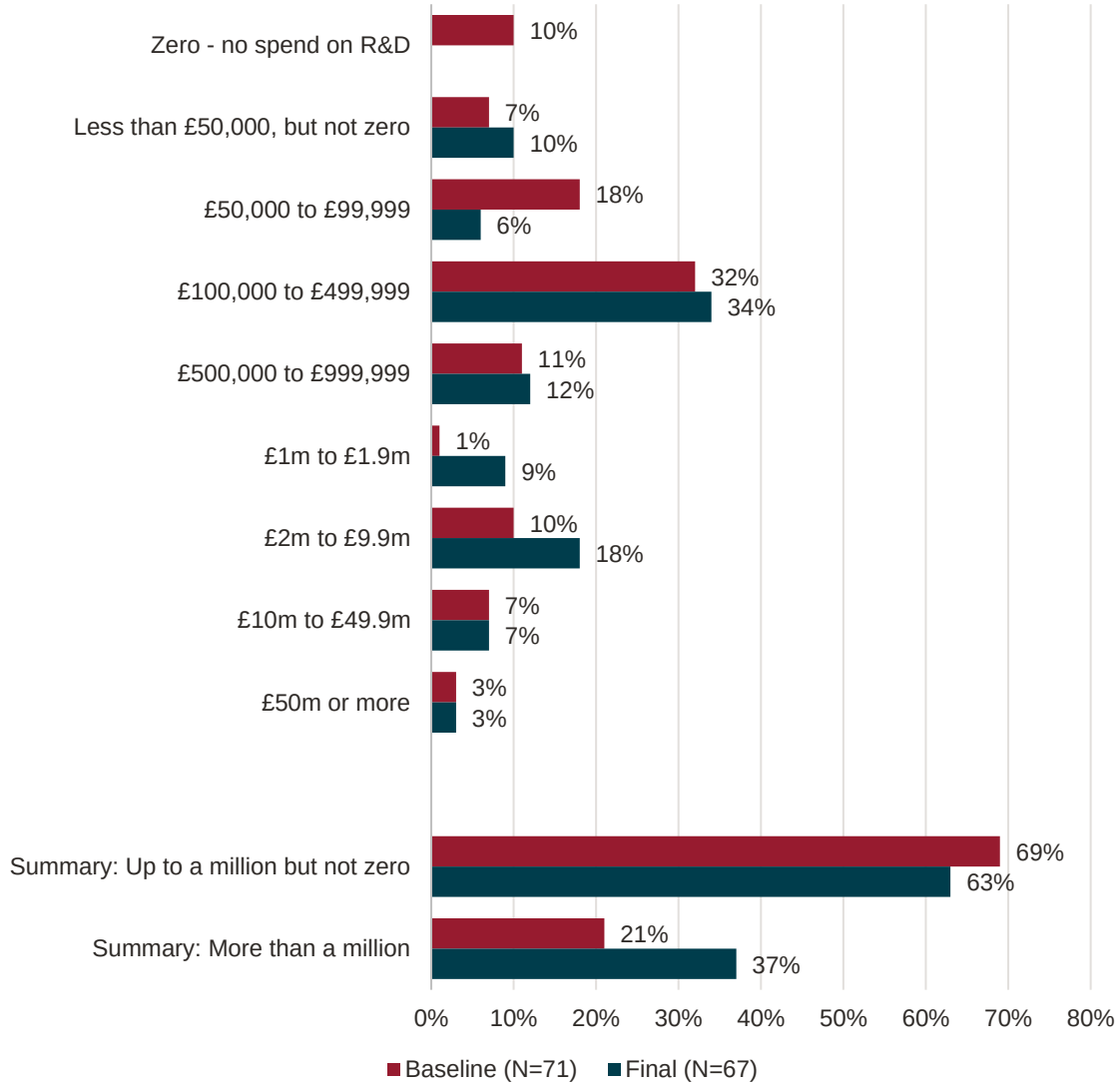
Note: The value of studies is given in nominal GBP. The data was extracted on 16/01/25.

Impact of FFC on R&D spending

Figure 28 indicates that nearly two-thirds (63%) of business respondents allocated up to £1 million to R&D activities in the 2022/2023 financial year, with the most common expenditure

range being £100,000 to £499,999 (34%). Additionally, 37% of respondents reported spending over £1 million on R&D, marking a significant increase from the baseline, where only 21% reported such levels of spending. Estimates of average R&D spending also reflect this upward trend, increasing from £4.4 million in 2019/2020 to £5.0 million in 2022/2023, a 14% rise over the period. Importantly this figure relates to all R&D spending rather than to future flight R&D specifically.

Figure 28 R&D spending in the previous financial year



Source: *Industry Survey. F1A/F1B. In the previous financial year how much did your company spend on research and development activities?*

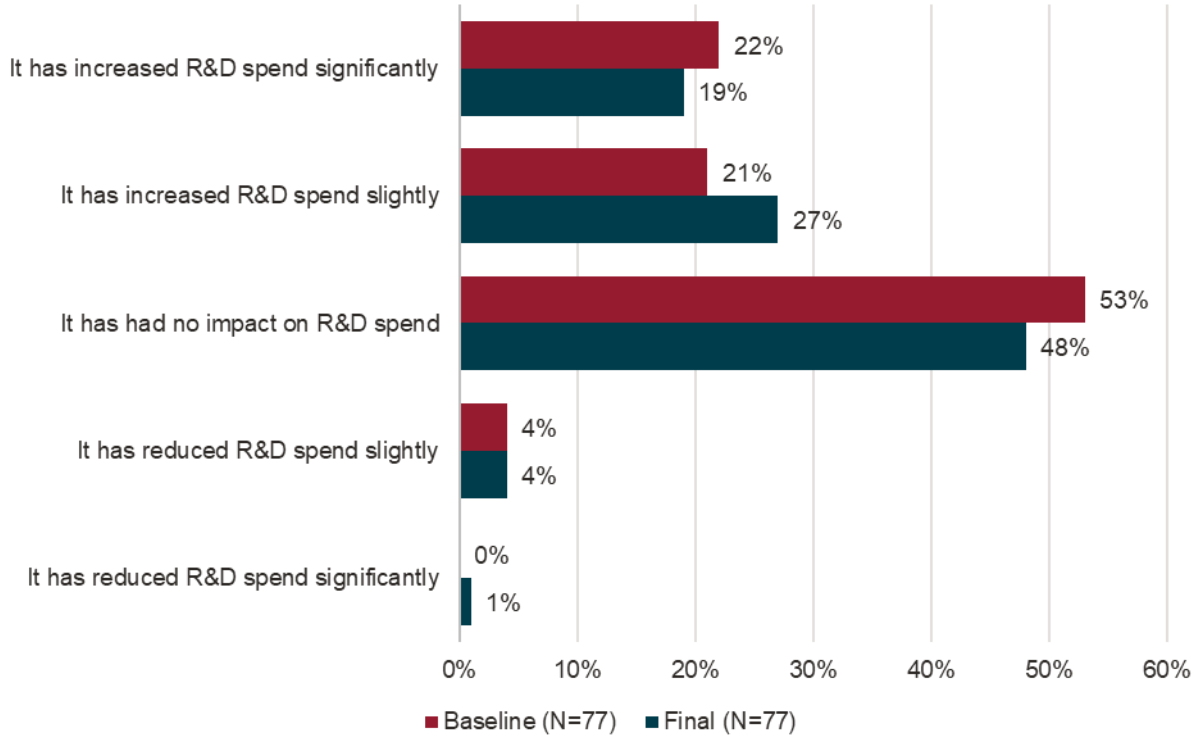
Note: *Base: valid responses (commercial businesses). Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Organisations involved in regulation and governance, as well as those dedicated to digital future flight infrastructure, were particularly likely to invest heavily in R&D, with 58% and 48% respectively reporting expenditures exceeding £1 million. This underscores the critical role

these organisations play in advancing innovation and infrastructure within the future flight sector.

Final and baseline survey respondents were also asked about the FFC's impact on their R&D spending. As shown in Figure 29, nearly half (46%) of final survey respondents indicated that their engagement with the FFC had increased their R&D spending. Of these, the vast majority (89%) indicated that this represented new funding. At baseline, around 43% of respondents indicated that the Challenge had increased their R&D spending, with 76% of those reporting that this was new funding. Both figures have therefore seen a slight increase since the baseline. Notably, respondents with an accepted FFC application were significantly more likely to report an increase in R&D spending, with 62% highlighting a positive impact.

Figure 29 Impact of FFC on R&D spending



Source: *Industry Survey. F2. What impact, if any, has the Future Flight Challenge had on your UK R&D spend?*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

In general, whether matched R&D spending was truly incremental depends on the alternative R&D activities that companies would have pursued in the absence of the FFC. For businesses engaged in diverse activities or operating across multiple sub-sectors (e.g., commercial airlines or engineering firms), it is more likely that the match funding required by the FFC was incremental. These companies would likely have redirected resources from non-future flight aerospace activities, suggesting that their participation in FFC projects represented an additional investment specifically aimed at advancing future flight technologies.

However, for companies specialising in core future flight technologies, such as BVLOS and AAM, it is possible that co-investment does not represent truly incremental investment in the sector. In the absence of the FFC, these funds may have been allocated to the development of other aspects of future flight technologies. Co-investment would only be considered incremental if companies sought additional capital from investors specifically to meet the match-funding requirements of FFC grants. However, there is evidence to suggest that R&D funding was diverted from other potential future flight projects as a result of the FFC.

3.6 Theme 5 – Has the Challenge helped to shape a coherent government policy that supports the development and operation of future flight technologies in the UK?

3.6.1 Overview

To assess this evaluation theme, we analysed the metrics summarised in Table 14.

Table 14 Theme 5. Government policy – Evaluation metrics

Subtheme	Metric	Data source
Trends in the perception of the degree to which government policy supports the future flight sector; comparison with other jurisdictions	Extent to which government policy is a barrier or an enabler	Survey data
	UK relative performance in terms of government policy compared to other jurisdictions	Survey data
	Stated impact of the FFC on degree to which government policy supports the development and growth of the future flight sector	Survey data, case studies

Source: Frontier Economics

Theme 5 – Key messages on government policy

- The government's strategic framework for the UK aviation sector is set out in the Flightpath to the Future strategy and the Future Flight Action Plan released by DfT in May 2022 and March 2024, respectively (under the previous administration). The FFC was actively involved in the development of both documents.

- The FFC has also supported and informed government policy in a range of other initiatives (e.g., Future Aviation Industry Working Group on Airspace Integration, Future Flight Community Integration Group, Aviation Council, Drones Industry Action Group, ADS AAM Market Group).
- A substantial majority of survey respondents felt that the FFC had positively influenced government policy in the UK. However, survey findings also show that government policy is increasingly perceived as a barrier to the development of future flight technologies. A third of respondents also believed the UK lags behind most countries, a significant increase since the baseline.
- Stakeholders interviewed mentioned that the UK had the potential to be a leader in UAS and AAM but this required a multi-departmental strategic vision from the government with clear milestones to match the pace of development seen in other jurisdictions.

3.6.2 Aims and activities

The FFC aims to shape the policy environment of the future flight sector, recognising it as a key enabler for establishing future flight technology clusters in the UK. Through its competition projects, the FFC has sought to identify and address policy gaps, ensuring that national and local policymakers are better informed about the sector's specific policy needs. Strengthened collaboration between industry and government was expected to support the development of coherent national policies and the establishment of necessary infrastructure. Simultaneously, improved communication was expected to help the sector better understand government policy directions, particularly where they align with the needs identified by competition projects. This, in turn, aims to reduce policy uncertainty and foster a more attractive environment for investment in the UK.

The anticipated benefits of the FFC on government policy are expected to emerge over a longer timeframe compared to other evaluation themes. From its inception, the FFC envisioned that its influence on shaping government policy would become evident by 2025. The FFC also anticipated that it would enhance the strategic outlook of both industry and government, fostering a more aligned and structured approach to advancing the future flight sector. While changes in the policy environment were expected to occur even without the FFC, they would likely have been slower and less impactful. In particular, communication between future flight sector companies and the government would have persisted, but the absence of the FFC would mean no sector roadmap or vision to guide cohesive strategy development.

It is important to note that a coherent government policy is not sufficient to help establish future flight technology clusters in the UK. As set out in the wider theory of change, factors beyond the control of the FFC, including macroeconomic and political conditions, external events and shocks (such as the Covid-19 pandemic and international conflicts), and advancements in international future flight clusters, will also clearly shape the sector’s development and competitive positioning.

The FFC was actively involved in the development of the previous government's strategic vision for the UK aviation sector, which is outlined in the ten-year plan "Flightpath to the Future",[30] published by the DfT in May 2022. The FFC provided strategic advice and expertise and conveyed the urgency of addressing emerging challenges and opportunities for the sector. The FFC was also involved in many of the policy-level activities outlined in the strategy, including:

- **Putting the sector on track to achieve Jet Zero by 2050**. The strategy emphasises the importance of extensive collaboration between government and industry, leveraging platforms like the Jet Zero Council (established in 2020 and replaced by the Jet Zero Taskforce in 2024). [31] The FFC influences the Taskforce's agenda through representation by the Department for Energy Security and Net Zero and Innovate UK.
- **Harnessing the potential of new technology and its use cases**. The strategy established the Future of Flight Industry Group (FFIG),[32] bringing together stakeholders from across technologies alongside the CAA, UKRI, and CPC to address shared challenges and establish deliverables.

The "Flightpath to the Future" strategy was succeeded by the "UK Future Flight Action Plan", released by DfT in March 2024. [33] The plan was co-designed by industry and government under the FFIG and was influenced by the FFC Vision and Roadmap.[34] It establishes a roadmap for developing and industrialising emerging aviation technologies, particularly UAS and eVTOLs, with the goal of positioning the UK as a global leader in the sector by 2030.

The plan outlines five strategic outcomes including achieving routine UAS operations by 2027 and delivering initial piloted operations carrying passengers and cargo for eVTOL by 2028. It also includes commitments from government, the CAA, and industry to enhance operational capabilities, streamline access and regulation, improve physical infrastructure, and drive sectoral growth. Key initiatives include scaling operations through the use of TRAs and implementing the UK SORA to standardise risk management. The delivery plan also introduces external accountability for the CAA, which stakeholders agree is crucial for accelerating regulatory innovation.

The FFC was instrumental in the early phase of the FFIG, with the intention of transitioning leadership of strategic areas to the CAA, the DfT, and industry for delivery of the plan. Moreover, the FFC is acknowledged as a key enabler of the plan's vision, serving as a vital link between industry and government to develop a shared vision for a "system of systems". Its contributions include building a strong evidence base through UAS and eVTOL

30 DfT (2022) Flightpath to the future

31 Jet Zero Taskforce

32 Future Flight Industry Group

33 DfT (2024) UK Future Flight Action Plan

34 UKRI/FFC (2021) Future Flight Vision Roadmap

demonstrations, assisting the CAA in identifying regulatory gaps, informing risk assessment processes, and identifying the legal implications of future flight technologies.

Other FFC activities to shape government policy

Other areas where the FFC has supported and informed government policy through its active participation in key initiatives and its development of forward-looking strategies and publications, include:

- **Future Flight Use Cases (2024):**[35] Presents a range of possible use cases to potential end-users to support the widespread adoption and commercialisation of new aviation technologies, including UAS, AAM, and other supporting services.
- **Future Aviation Industry Working Group on Airspace Integration (2023):** As a founding member and co-chair, the FFC played a pivotal role in the publication of the "Let's Get Flying"[36] action plan in February 2023. This document offers targeted actions and highlights benefits for government, industry, and regulators, advancing efforts toward effective airspace integration.
- **Future Flight Community Integration Group (2023):** Established to incorporate local authorities into central government deliberations, this group ensures that future flight initiatives address community needs and regional considerations. In July 2024, it published the Community Integration Local Planning Guidance Paper[37] to guide the UAS and AAM industry. The paper provides recommendations on leveraging existing local planning frameworks, tools, and policies to integrate these technologies into ground operations and airspace. It also highlights the physical infrastructure required and identifies gaps in the current UK local planning framework, offering a pathway for smoother adoption and regional alignment of future flight technologies. It has also commissioned two other reports to assess the industry's training resources, and a regional use case study.
- **Aviation Council (2023):** As part of the "Flightpath to the Future" strategy, this council brings together representatives from across the aviation sector, alongside cross-government and devolved administrations. The FFC's involvement ensures that future flight perspectives are integrated into broader aviation policymaking.
- **Drones Industry Action Group (DIAG) (2022):** The FFC's membership in the DIAG has contributed to the Ambition Statement[38] for the drone sector jointly published by the group and the government, setting priorities and actions to support the growth of the UK drone industry.

35 Innovate UK (2024) "Future flight use cases: 9 ways future flight will transform aviation"

36 UKRI (2023) "Let's get flying: out plan for action"

37 UKRI/Innovate UK (2024) Community Integration Local Planning Guidance Paper

38 BEIS & DfT (2022) "Advancing airborne autonomy: Commercial drones saving money and saving lives in the UK"

- **Future Flight Vision and Roadmap (2021):** Outlines the vision for the UK's aviation system by 2030, offering strategic roadmaps to position the UK as a global leader in advanced aviation solutions. By presenting industry vision statements and use cases, it highlights key challenges and opportunities, shaping government policy to align with the sector's long-term goals.
- **ADS Advanced Air Mobility (AAM) Market Group (2021):** The FFC's contributions have supported the development of key publications, such as the ADS AAM Annual Market Outlook, which provides a foundational baseline for government and industry stakeholders to develop investment business cases across the sector.
- **Safety Case Framework (2021):** Provides a comprehensive view on aviation safety, drawing insights from a broad cross-section of the aviation industry. The framework considers the evolving aviation landscape, including operational scenarios for introducing novel forms of transport, as well as system risk factors and regulatory requirements.

Government stakeholders interviewed during the interim evaluation in 2023 highlighted the FFC's crucial role in accelerating the establishment of the FFIG by addressing a communication gap between industry and government. Unlike traditional aerospace sectors, which are dominated by a few large companies, the future flight sector comprises many smaller organisations, complicating direct government engagement. The FFC streamlined this process by consolidating and prioritising industry insights, enabling the government to set realistic policy objectives and efficiently structure the FFIG's agenda.

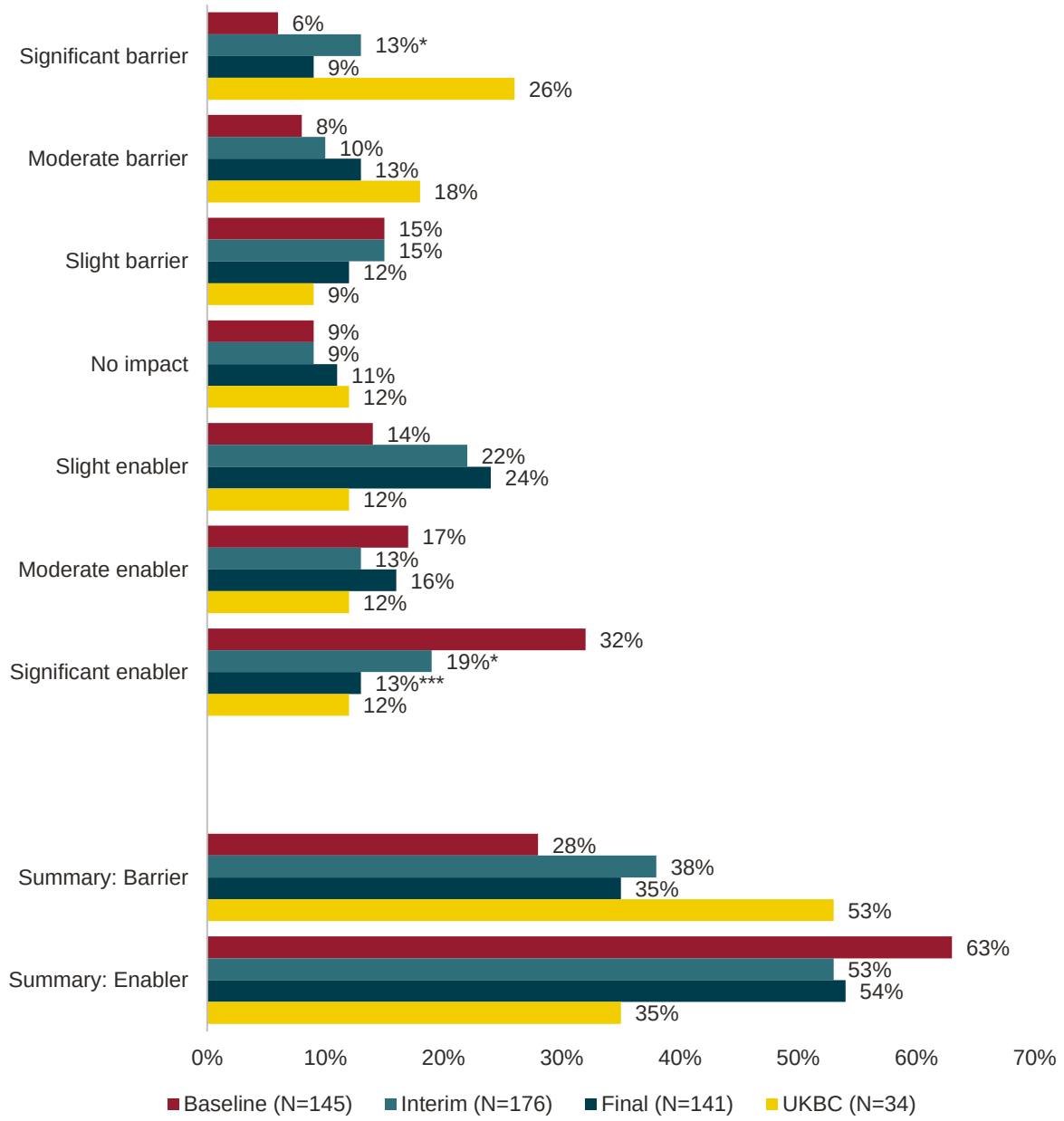
Interim evaluation interviewees highlighted how the FFC has also facilitated faster progress by reducing barriers to industry participation and overcoming administrative challenges, with its "Vision and Roadmap" cited as valuable strategic tools. However, at the time of the interim evaluation, stakeholders emphasised the need for senior political sponsorship and high-profile demonstrations to enhance cross-government coordination and sustain momentum in advancing the future flight sector.

3.6.3 Evaluation evidence

Figure 30 shows respondents' perceptions of government policy as either a barrier to or enabler of advancing future flight technology in the UK. Views of policy as an enabler remained stable since the interim survey, with 54% of final survey respondents indicating that policy supports technological progress.

However, over one-third (35%) saw government policy as a barrier, reflecting persistent challenges in aligning policy with industry needs. Notably, the proportion of respondents who considered policy as a "significant enabler" decreased significantly compared to the baseline survey (13% vs. 32%) and fell slightly compared with the interim evaluation, suggesting reduced confidence in the transformative impact of policy. Among UKBC contacts, the majority (53%) perceived government policy as a barrier, while only 35% viewed it as an enabler. Respondents with successful Challenge applications were more positive, with 61% stating that government policy had facilitated the progression of future flight technologies.

Figure 30 Extent to which government policy is a barrier or an enabler



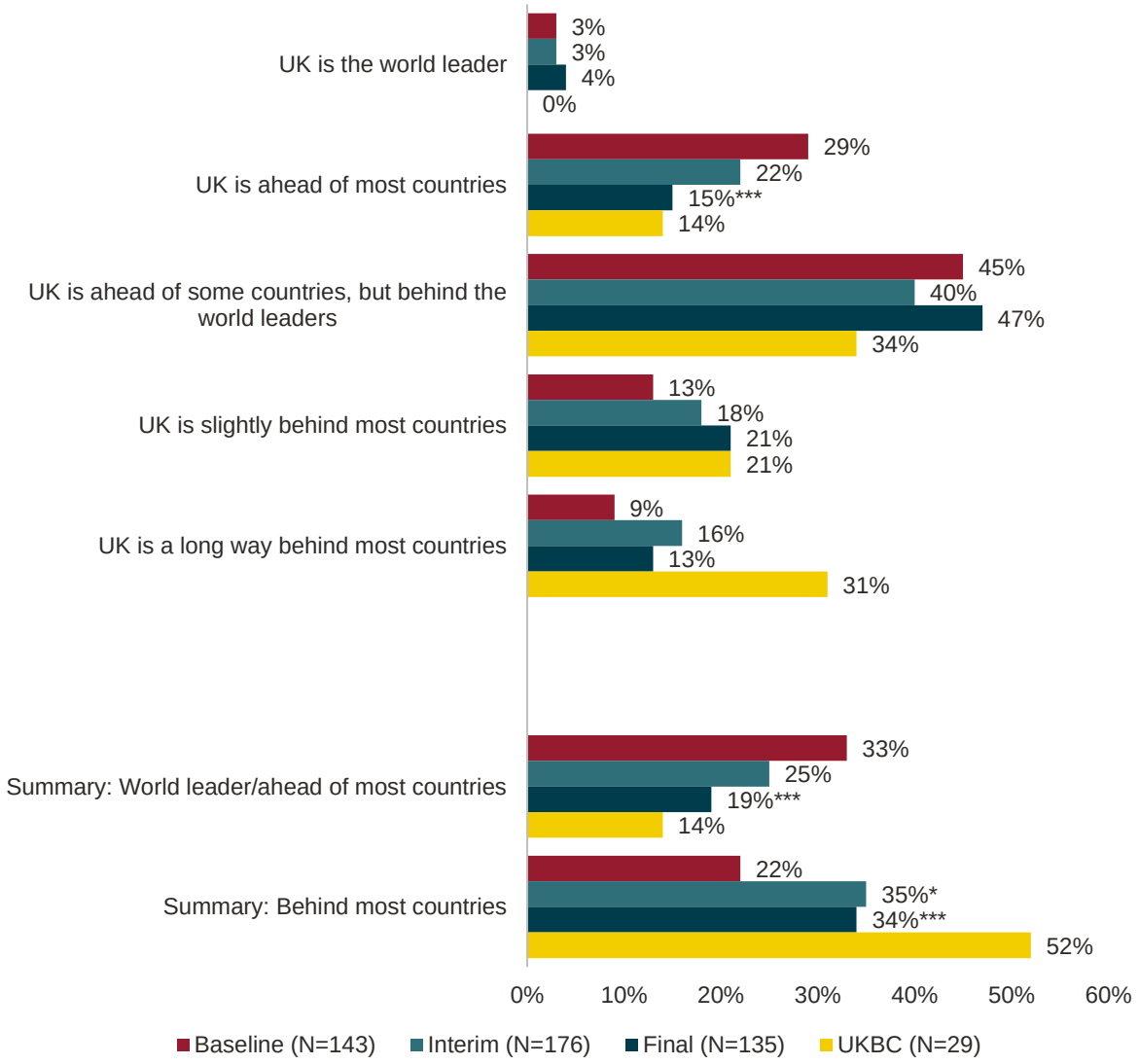
Source: *Industry Survey. C5/3. For each of the following, please indicate whether you think they are a barrier or enabler to the progression of future flight technology in the UK: Government policy towards future flight technologies (e.g. planning rules, environmental targets).*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Figure 31 illustrates how respondents assessed the UK's performance in government policy toward future flight technologies compared to other countries. Only 19% of final survey respondents believed the UK was a world leader or ahead of most countries in this area, marking a significant decline from the 33% recorded in the baseline survey and a further drop from the 25% at the interim evaluation. Conversely, 34% of final survey respondents felt the UK lagged behind most countries, a notable increase from the 22% reported in the baseline,

although essentially unchanged from the interim evaluation. As expected, perceptions among UKBC organisations were more negative, with 52% of respondents stating that the UK fell behind other countries.

Figure 31 UK performance in terms of government policy towards future flight technologies



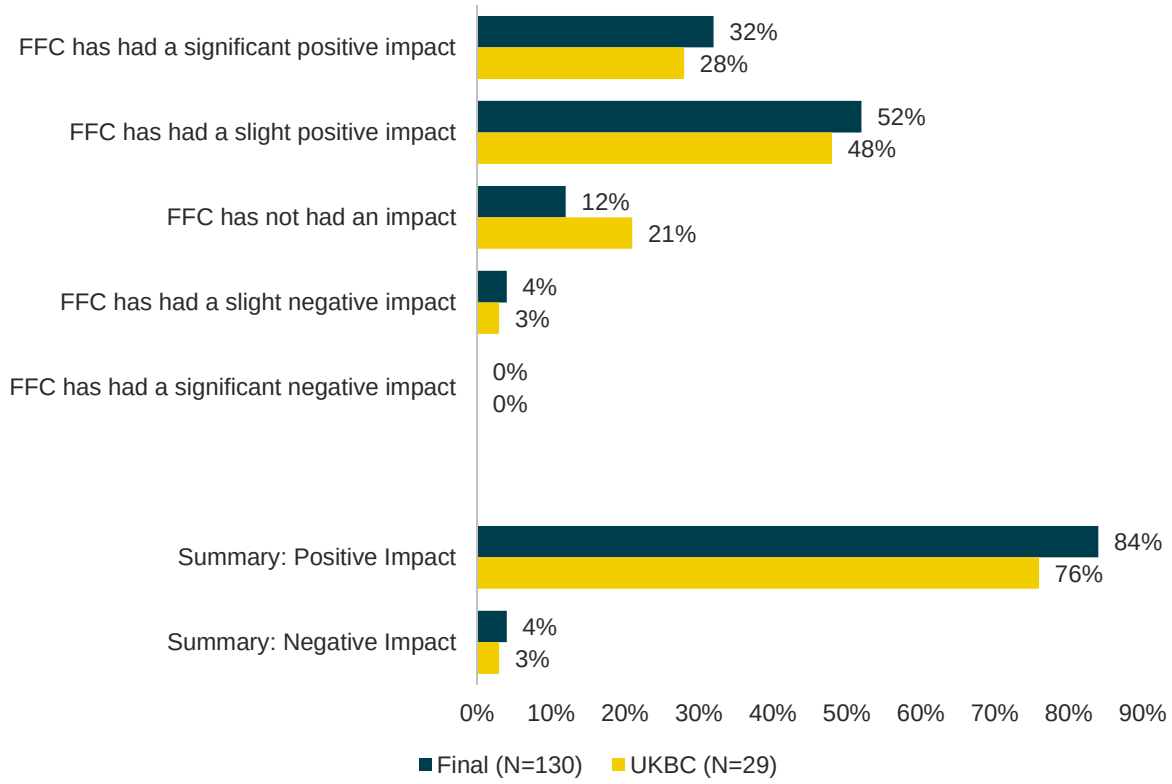
Source: *Industry Survey. C1/3. I'm now going to read out some elements of future flight technology development and support. For each, please can you tell me how you think the UK is currently performing in comparison to other countries?: Government policy towards future flight technologies (e.g. planning rules, environmental targets).*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

These findings highlight ongoing challenges in aligning UK government policy with the needs of the future flight sector and maintaining competitiveness on the global stage.

In the final survey, respondents were asked about the perceived impact of the FFC on government policy supporting the development and growth of the future flight sector. As shown in Figure 32, a substantial majority (84%) of respondents felt that the FFC had positively influenced government policy, while only 4% believed its impact had been negative. UKBC respondents shared similarly positive views, with 76% acknowledging the FFC's positive impact on policy.

Figure 32 Impact of FFC on degree to which government policy supports the development and growth of the future flight sector

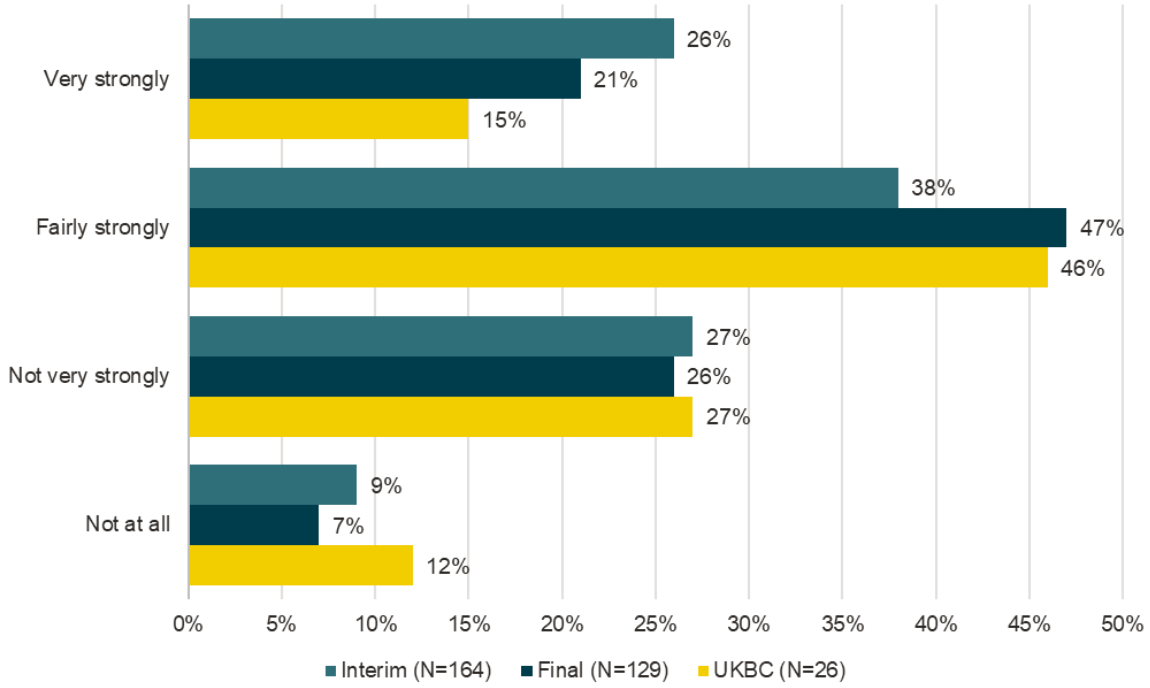


Source: *Industry Survey. C6. What impact, if any, do you think the FFC has had in the degree to which government policy supports the development and growth of the future flight sector?*

Note: *Base: valid responses.*

Respondents in both the interim and final surveys were asked to assess the alignment of the FFC with other government initiatives. As shown in Figure 33, perceptions have remained stable over time, with 67% of final survey respondents indicating that the FFC aligns well with other government initiatives. However, 33% felt that the alignment was not strong, suggesting room for improvement in ensuring coherence and synergy between the FFC and broader government programmes.

Figure 33 Extent to which the FFC aligns with other government initiatives in the UK



Source: *Industry Survey. B11. How well do you think the Future Flight Challenge aligns with other government initiatives in the UK?*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Stakeholders interviewed as part of the case studies agreed that the UK had the potential to be a leader in the UAS and AAM sectors, but this required ongoing investment and strategic vision from the government to match the pace of development seen in other jurisdictions. There was a call for the government to articulate a clear vision and strategy for the future flight sector, ensuring that the UK remains competitive in the global market. In fact, the majority of the stakeholders interviewed were not aware of the "Flightpath to the Future" strategy or the "Future Flight Action Plan", at least not by name.

One stakeholder mentioned that future interventions should aim for a cross-departmental approach to integrate various government efforts and support the commercialisation and industrialisation of future flight technologies.

> *"We need to see that vision and we need to agree with government what is going to be the strategy to make it happen in the UK. The Challenge can be quite useful to integrate things that need to happen from different departments in a single strategy." – Industry strategy*

3.7 Theme 6 – Has the Challenge helped to improve public attitudes to future flight technologies?

3.7.1 Overview

To assess this evaluation theme, we analysed the metrics summarised in Table 15.

Table 15 Theme 6. Public attitudes – Evaluation metrics

Subtheme	Metric	Data source
Trends in the perception of public attitudes towards future flight technologies; comparison with other jurisdictions	Extent to which public attitudes policy is a barrier or an enabler	Survey data, FFC social science research outputs
	UK relative performance in terms of public attitudes towards future flight technologies compared to other jurisdictions	Survey data
	Stated impact of the FFC on public attitudes towards future flight technologies	Survey data

Source: Frontier Economics

Theme 6 – Key messages on public attitudes

- Research conducted by the Challenge highlights that public perceptions of future flight technologies are mixed, with support for applications like emergency services but concerns over safety, privacy, and environmental impact hindering broader acceptance.
- Survey respondents' perceptions of public attitudes as an enabler of or barrier to the future flight sector remained largely unchanged. However, those with limited engagement in the Challenge were more likely to view public attitudes as a barrier.
- Among survey respondents, there was a generally positive perception of the Challenge's role in improving public attitudes.
- The UK was viewed by survey respondents as lagging internationally in public attitudes toward these technologies, despite the FFC's efforts to positively influence awareness and address concerns.
- Transparent communication, robust regulation, and active public engagement are essential to overcoming barriers and fostering widespread acceptance.

3.7.2 Aims and activities

The FFC seeks to influence public acceptance of future flight technologies, a key enabler of the establishment of future flight technology clusters and their deployment in the UK. Increased public acceptance and end-user demand broaden the range of commercially viable applications, enabling companies to more easily demonstrate and market these technologies domestically. This, in turn, enhances the UK's attractiveness as a hub for economic clusters specialising in the production and innovation of future flight technologies, driving sector growth and competitiveness.

At the time the Challenge commenced, its impact on public perceptions of future flight technologies was expected to develop gradually. From its inception, the FFC has aimed to enhance the social desirability and demand for these technologies by fostering a deeper understanding of public attitudes. This approach involves both adapting technologies to align with public preferences and designing targeted outreach activities to address concerns, thereby promoting greater acceptance and support for the adoption of future flight innovations.

While improved social desirability of future flight technologies was expected to evolve even in the absence of the FFC, its contribution was anticipated to be towards faster and more comprehensive acceptance. For example, noise reduction techniques, which play a pivotal role in shaping public perception, might not have advanced as rapidly without FFC-supported initiatives. The FFC is designed to accelerate these efforts, ensuring a more proactive and structured approach to increasing public acceptance.

Clearly, improved public attitudes are not themselves sufficient to help establish future flight technology clusters. As set out in the wider theory of change, factors beyond the control of the FFC, including macroeconomic and political conditions, external events and shocks (such as the Covid-19 pandemic and international conflicts), and advancements in international future flight clusters, will also clearly shape the sector's development and competitive positioning.

The FFC, in coordination with the Economic and Social Research Council (ESRC), commissioned research into the social science aspects of the future flight sector, appointing a team of academics to lead the initiative. This work culminated in the publication of the "Future Flight Social Science Considerations and Research" report in December 2021.[39] Research topics were identified and prioritised under the guidance of the FFC Research Director, whose responsibilities included producing academic papers and reports, organising conferences, and conducting surveys to advance understanding in this area.

The social science workstream leveraged the expertise and methodologies developed by the ESRC, UKRI, and academic researchers from their work in other technology fields and applied them to the future flight sector. Through this approach, the FFC aimed to establish a novel area of interdisciplinary research, focusing on aspects not currently explored by comparable

[39] UKRI (2021) "Future Flight Social Science Considerations and Research"

international organisations such as understanding public attitudes toward future flight technologies. Social science research activities undertaken so far include:

- **Public awareness survey:** In collaboration with the University of Birmingham, the FFC collected survey data to assess the UK public's general awareness and understanding of future flight technologies in 2024.[40] The survey aimed to explore public hopes, concerns, and expectations regarding drones, AAM, and electric and hydrogen-powered regional aircraft.

- **Public attitude research:** Qualitative evidence on public perceptions was collected using a deliberative methodology, allowing participants to engage with unfamiliar technologies. The aim of this research was to understand public views on the potential operation of future flight technologies in the UK and offer the public the opportunity to feed into regulation, policymaking, and technological development. The findings were published in research reports in July 2022 ("Future Flight Challenge – Mini Public Dialogue")[41] and in July 2024 ("Framework for Future Flight in the UK: Principles from a Deliberative Public Dialogue").[42]

- **Project grants:** Up to seven project grants, each valued at up to £150,000, were made available for UK-based researchers eligible for ESRC funding. Beginning in April 2023 and expected to conclude by March 2025, these grants focus on themes including:

  - **Innovation by and for social and community need:** Addressing inclusive design and implementation of future flight systems, with subthemes covering disability and accessibility, marginalised groups' experiences, digital exclusion, and socio-economic inclusion.
  - **Future flight ecosystems and enterprises:** Investigating the dynamics of the future flight innovation ecosystem.
  - **Governance and trustworthiness:** Exploring the role of UK governance and policy in enabling or constraining future flight technologies.
  - **Spatiality of future flight:** Examining the geographical implications and impacts of future flight technologies on communities.

- **Policy fellowships**: Two policy fellowships, starting in April 2023 and lasting up to 12 months, were designed for eligible UK-based researchers. The first fellowship focused on a comparative economic and environmental assessment of investments in future flight versus other transport modes. The second fellowship aimed to explore how future flight technologies can be integrated into the UK-wide transport system.

40 UKRI/Innovate UK, University of Birmingham and YouGov (2024) Future Flight Survey 2024

41 UKRI/Innovate UK (2022) "Future Flight Challenge: Mini Public Dialogue"

42 UKRI/Innovate UK (2024) "Framework for Future Flight in the UK: Principles from a Deliberative Public Dialogue"

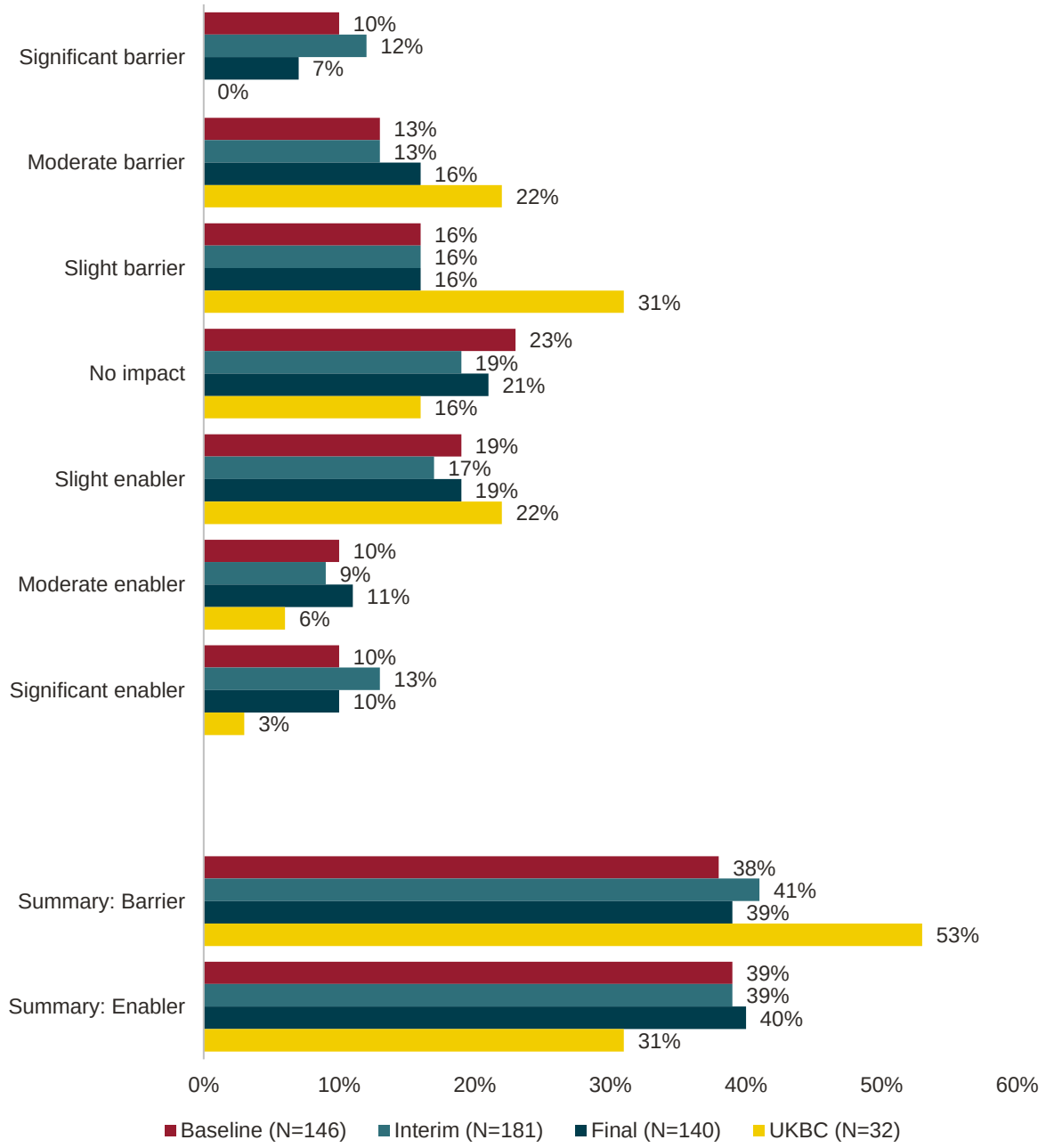
- **Social science integration in Demonstration Phase projects:** The FFC provided guidance to Demonstration Phase applicants on incorporating social science dimensions into their projects. This initiative sought to align project outputs with public and user needs.

During the interim evaluation, the FFC portfolio review highlighted that the overall project portfolio placed significant emphasis on the social readiness of technologies and the demonstration of viable new markets. However, a shift in focus was observed between the Development and Demonstration Phases. Projects in the Development Phase typically had a broader scope, addressing the societal uses and potential benefits of future flight technologies. In contrast, during the Demonstration Phase, the focus narrowed considerably, prioritising the preparation and execution of demonstrations over broader societal considerations. This shift reflects the transition from exploratory stages to more practical, application-oriented activities.

3.7.3 Evaluation evidence

Figure 34 illustrates how respondents perceived the role of public perceptions in the advancement of future flight technologies in the UK. Across all three evaluation surveys, opinions remained stable, with 40% of final survey respondents viewing public perceptions as an enabler of and 39% as a barrier to progress. Meanwhile, 21% believed that public perceptions had had no significant impact on technological advancement. Among UKBC respondents (those who had more limited engagement with the Challenge), public perceptions were more commonly viewed as a barrier, with 53% identifying them as such, while 31% considered them as an enabler. These findings highlight a divided outlook on the influence of public perceptions within the future flight sector.

Figure 34 Extent to which public perceptions of future flight technologies are a barrier or an enabler



Source: *Industry Survey. C5/7. For each of the following, please indicate whether you think they are a barrier or enabler to the progression of future flight technology in the UK: Public perceptions of future flight technologies*

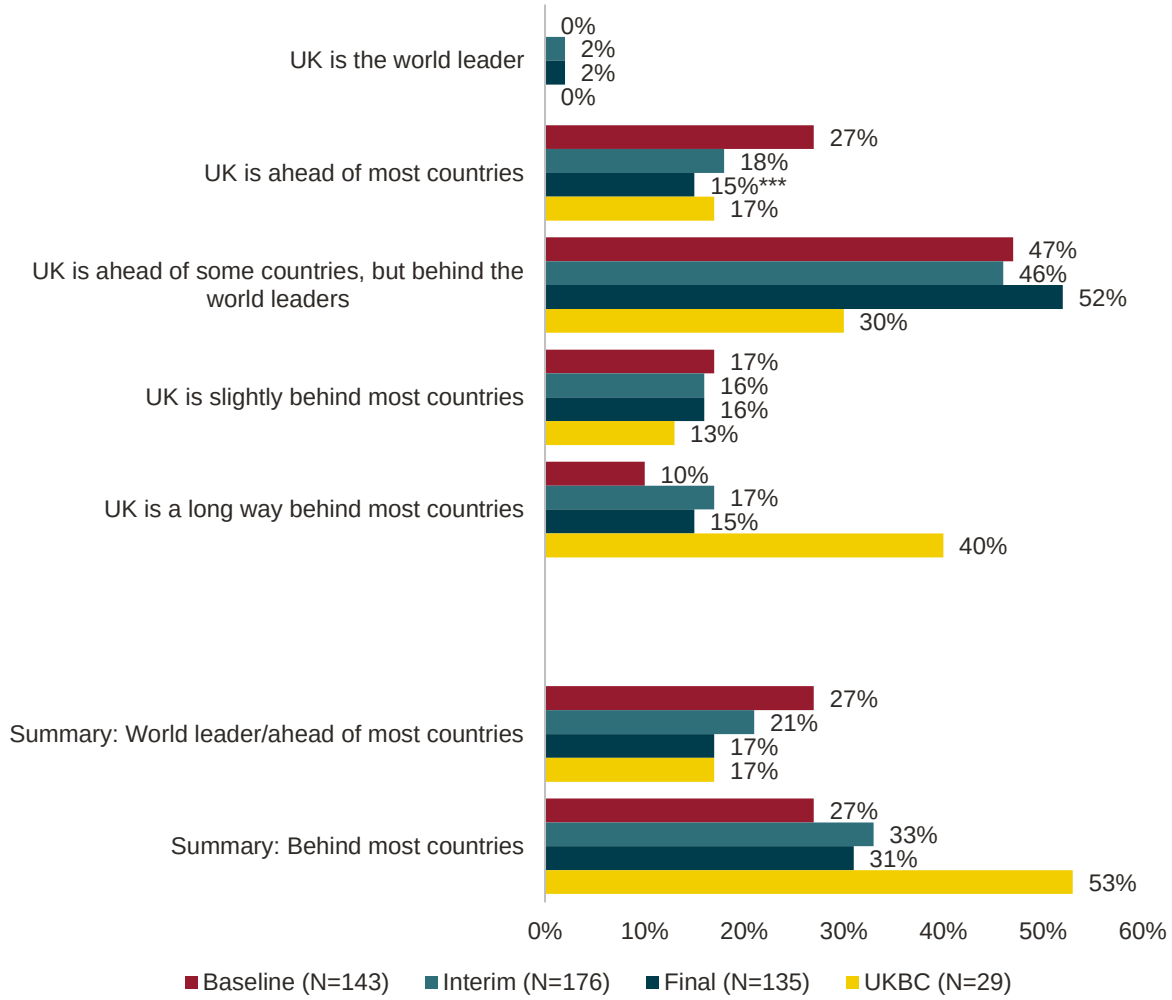
Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Figure 35 shows respondents' views on the UK's performance in public perceptions of future flight technologies compared to other countries. Among final survey respondents,

perspectives were predominantly negative, with 31% stating the UK lagged behind most countries and only 17% identifying the UK as a world leader, consistent with interim survey results. Furthermore, the proportion of respondents who felt the UK was ahead of most countries dropped significantly from the baseline survey (15% compared to 27%).

UKBC respondents were even more critical, with 53% stating that the UK was behind most countries in terms of public perceptions, while only 17% said the UK was a world leader or ahead of most countries. Among subgroups of respondents, those with accepted FFC applications (31%) and researchers (29%) were more likely to view the UK as a leader in this area, reflecting greater optimism among these groups.

Figure 35 UK performance in terms of public perceptions of future flight technologies

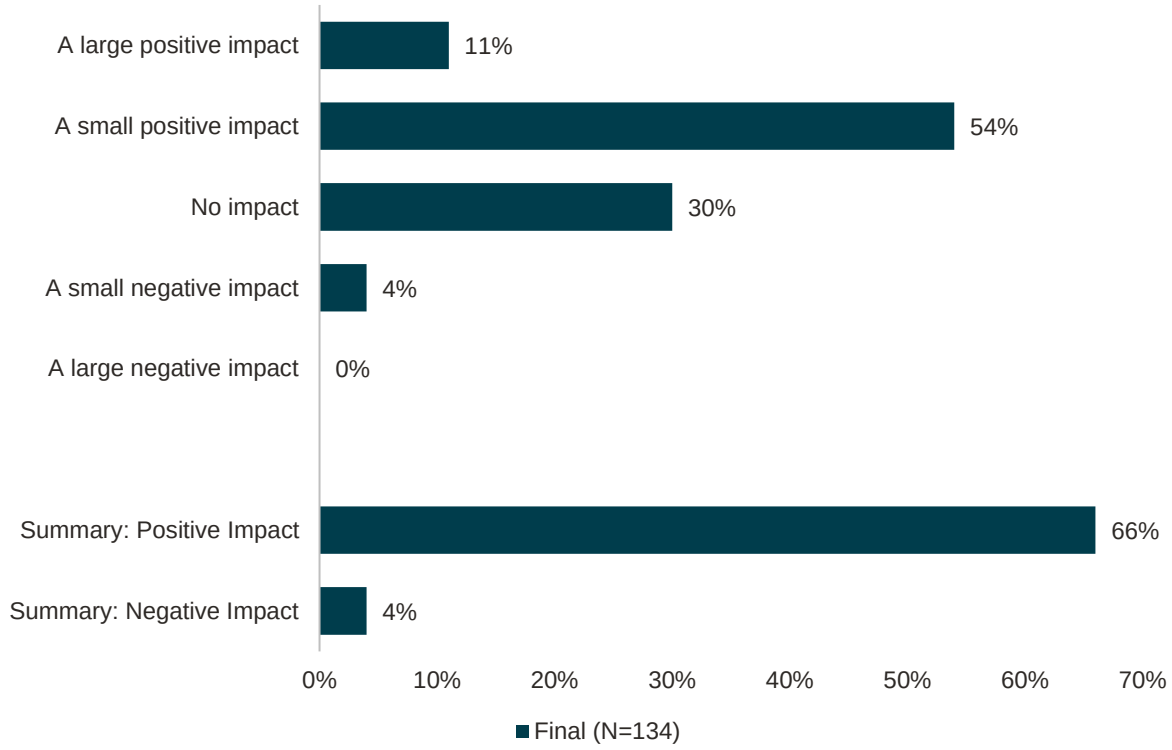


Source: *Industry Survey. C1/7. I'm now going to read out some elements of future flight technology development and support. For each, please can you tell me how you think the UK is currently performing in comparison to other countries?: Public perceptions of future flight technologies.*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

In the final evaluation survey, respondents were asked to assess the FFC's influence on public attitudes toward future flight technologies in the UK. As shown in Figure 36, two-thirds (66%) reported that the FFC had had a positive impact, reflecting its efforts to address public concerns and build awareness of these technologies. Only 4% felt the FFC had had a negative impact, while 30% indicated that it had not influenced public attitudes, highlighting potential areas where further outreach and engagement might be needed.

Figure 36 Impact of FFC on public attitudes towards future flight technologies in the UK



Source: *Industry Survey. F8. What impact, if any, do you think the FFC has had on public attitudes towards future flight technologies in the UK?*

Note: *Base: valid responses.*

The Challenge-led Future Flight Survey 2024[43] offers comprehensive insights into public awareness, perceptions, and expectations regarding emerging aviation technologies including drones, eVTOLs, and electric or hydrogen regional air mobility. The survey was conducted in March/April 2024 and included a sample of 3,279 adults living in the UK. Awareness levels varied significantly, with most respondents familiar with drones (95%) but far fewer aware of eVTOLs (28%) or regional air mobility technologies (24%).

Public perceptions of these technologies were nuanced, with notable support for applications like emergency services and access to isolated areas. However, concerns persisted about

43 UKRI/Innovate UK, University of Birmingham and YouGov (2024) Future Flight Survey.

cybersecurity, safety, and environmental impacts, alongside scepticism about whether these technologies would meaningfully address climate change. Looking ahead, there was optimism about the adoption of drones for non-passenger applications, but less confidence in the widespread use of eVTOLs, with comfort levels rising only after technologies have been operational for several years.

Moreover, recent qualitative research on public perceptions from a deliberative public dialogue revealed mixed initial attitudes, with concerns focused on noise, safety, sustainability, accessibility, and privacy. Participants also recognised potential benefits, such as improving rural connectivity and enhancing emergency services. However, they emphasised the importance of aligning these technologies with public good principles, including affordability, inclusivity, and environmental sustainability, to unlock their full social benefits. Participants stressed the need for robust regulatory frameworks and independent monitoring to address concerns.

The qualitative findings from case studies suggest that before the Challenge, public scepticism regarding future flight technologies, particularly concerning safety and privacy, acted as a significant indirect barrier for development. Stakeholders agreed that FFC initiatives to raise public awareness about the benefits of future flight technologies had positively influenced perceptions of specific use cases (e.g., medical emergency response).

For example, Project CAELUS[44] was highlighted by stakeholders as a key enabler to increase awareness among the general public and media outlets about potential use cases of UAS operations and its potential live-saving benefits. Additionally, research from Project XCelerate[45] indicates that approximately 68% of the UK public now view UAS as having a positive impact, reflecting relatively strong acceptance for use cases such as emergency response and rural connectivity.

This improved awareness has, in turn, driven greater demand from end-users for operational deployment and in-service applications. Despite this progress, significant public concerns persist which highlight potential barriers to the successful commercialisation and widespread adoption of some technologies and use cases.

Some large organisations interviewed expressed concerns about the focus on promoting futuristic concepts like “flying taxis” without tangible in-service operations to showcase, potentially leading to unmet public expectations. Stakeholders emphasised that this could harm the sector’s reputation and social acceptance of future flight technologies. They highlighted the importance of managing expectations by prioritising communications and

[44] Project supported by the FFC during the Demonstration Phase (2022-2025) which aims to show the operation of a network of multiple electric drones for the distribution of medical products and medicines across Scotland. Led by AGS Airports.

[45] Project supported by the FFC during the Development Phase (2021-2022) led by BT Group. It aimed at establishing the first commercial drone corridor in open and unrestricted airspace to prove how drones and manned aviation can safely co-exist.

advertisements on achievable, near-term technologies and operations, supported by physical demonstrations that can foster public trust.

3.8 Theme 7 – Has the Challenge helped to build the skills needed to support future flight technologies?

3.8.1 Overview

To assess this evaluation theme, we analysed the metrics summarised in Table 16.

Table 16 Theme 7. Skills – Evaluation metrics

Subtheme	Metric	Data source
Trends in the perception of skills; comparison with other jurisdictions	Extent to which workforce skills is a barrier or an enabler	Survey data
	UK relative performance in terms of workforce skills compared to other jurisdictions	Survey data
	Stated impact of the FFC on workforce skills	Survey data, FFC monitoring data
Engagement from local authorities	Perceptions of local authority engagement before and after competitions	Survey data

Source: Frontier Economics

Theme 7 – Key messages on skills

- In 2023, the FFC allocated £500,000 to 13 short-term projects aimed at creating targeted course content for a diverse range of audiences, including schools, apprenticeships, vocational training, and continuing professional development (CPD).
- Survey results show a cautious outlook on the UK's workforce skills in the future flight sector. While workforce skills were generally viewed as an enabler by a majority of final survey respondents, there was a notable increase in those identifying them as a barrier compared to earlier surveys, reflecting growing concerns about skill gaps in the sector.
- Perceptions of local authority engagement in future flight technologies were divided, with survey respondents evenly split between viewing it as a barrier, enabler, or having no impact. Stakeholders working on infrastructure projects were more optimistic, highlighting potential for local authority collaboration to support sector progress.

3.8.2 Aims and activities

From its inception, workforce skills were identified by the Challenge as a critical enabler for advancing future flight technologies and establishing technology clusters in the UK. The Challenge aims to address workforce skill gaps to drive technological innovation, facilitate knowledge transfer, and support collaboration with local government and other sectors.

The anticipated effects of the FFC on workforce skills are expected to materialise gradually, with observable changes from 2025 onward. While skill development in the sector might naturally evolve, it was expected that the Challenge would play a pivotal role in structuring and accelerating this growth by generating demand for new skills (e.g., relevant net zero technologies, AI, machine learning, etc.) through funded R&D projects and demonstrations, providing valuable insights into the sector's evolving requirements.

It is worth noting that building the skills needed is not sufficient to help establish future flight technology clusters in the UK. As set out in the wider theory of change, factors beyond the control of the FFC, including macroeconomic and political conditions, external events and shocks (such as the Covid-19 pandemic and international conflicts), and advancements in international future flight clusters, will also clearly shape the sector's development and competitive positioning.

To achieve its objective, the FFC has provided support for strategic activities and interventions that aim to encourage students to pursue science, technology, engineering and mathematics (STEM) higher education, upskilling the UK's aviation workforce, and providing enhanced vocational training and CPD opportunities. In 2023, the FFC allocated £500,000 to develop upskilling programmes aimed at creating targeted course content for a diverse range of audiences, including schools, apprenticeships, vocational training, and CPD. These grants are supporting 13 short-term projects with the involvement of almost 18 organisations.

FFC Skills competition (2023-2025)– Winning projects

- **Hydrogen STEM Research Programme:** Aimed at empowering secondary school students across the UK to learn about net zero aviation. Led by Zeroavia and IRIS.
- **InnovateHer:** STEM Cybersecurity Leaning Programme with the participation of almost 100 students aged 13-17 in 15 state schools across England. Led by Innovating Education.
- **Project FLAME:** Future leaders for AAM Excellence brings together academia and industry to develop a postgraduate course for the AAM sector. Led by the University of West London in collaboration with Safeguard Engineering and COPTRZ, a commercial drone retailer.
- **DroneOps VS:** Virtual reality training for drone hazard awareness and flight planning. Led by Nudge Reality.

- **AMM Flight Dynamics and Performance Skills.** Further education course offered to undergraduate aerospace engineering students and as CPD. Led by University of Nottingham.
- **digiLab Academy:** Online CPD and upskilling training course named "AI in the Wild – Foundations in Machine Learning for Future Flight". Led by digiLab.
- **Aviation Sector Insight Mentoring:** Project dedicated to supporting young people to explore a range of career and higher education options withing the drone and aviation sectors by pairing them with industry mentors. Led by The Brightside Trust in collaboration with ARPAS, a UK drone trading association.
- **UAM4Gov:** Aimed at closing the AAM/UAM skills gap for members of city and local government with an internet-based educational platform. Led by AAM Gov.
- **Future Flight in Further Education:** STEM programme with the participation of 400 students across 11 colleges. Led by Harlow College with the collaboration of CAA, DfT and other industry stakeholders.
- **BVLOS Drone Pilot Training Course:** Led by Snowdonia Aerospace.
- **Project Elevate:** Programme of tests and certification to bring remote pilot skills up. Led by Global Drone Training in collaboration with the Engineering Construction Industry Training Board.
- **Stackable Programme on AAM:** Training programme targeted at engineers in the overall "systems of systems" architecture of integrated ATM and UTM ecosystems. Led by Cranfield University.
- **Risk Quantification Unlocking BVLOS operations:** Training course to support the development of safety cases. Led by Aerofirm and ARPAS.

The FFC has also contributed to advancing STEM education by supporting a school outreach programme in collaboration with the Institute of Engineering Technology (IET). The IET Faraday Challenge Day is a nationwide annual competition where pupils aged 12-13 are faced with real-world challenges spanning STEM themes. In the 2022/23 season, the competition's theme, developed in association with the FFC, focused on future flight technologies. Teams were tasked with designing a drone prototype capable of making deliveries. As part of this competition, the IET also supplies schools with resources and guidance to facilitate their own challenges, broadening the programme's reach and impact.

These initiatives aim to enhance workforce readiness, support supply chain growth, and improve mutual understanding between policymakers and the sector. Enhanced mutual awareness enables the government to develop coherent policies that address skill shortages and infrastructure needs while providing supply chain companies with a clearer view of future flight opportunities through sector roadmaps.

Projects undertaken during the Development (2021-2022) and Demonstration (2022-2025) Phases have also placed a strong emphasis on identifying and addressing new skill requirements within the future flight sector. During the Development Phase, significant skills gaps were identified by FFC's stakeholders across various domains, including engineering,

software development, infrastructure management, and operational expertise. Moreover, technology-specific knowledge emerged as a critical need in areas such as UTM, BVLOS, hydrogen technologies, and autonomous vehicles. The evolving nature of the sector also highlighted the importance of developing skills for new roles, including drone air traffic control authorisation, AI operations, remote piloting, and vertiport operations. The Demonstration Phase has focused on higher TRL projects, which demand more advanced and specialised skills.

Stakeholders interviewed during the interim evaluation in 2023 highlighted ongoing shortages in critical areas of expertise, such as digital skills, systems engineering, and manufacturing capabilities. They also noted the emergence of new skill requirements driven by technological advancements. These evolving skill needs span a range of domains, including technology development (e.g., infrastructure design and autonomous systems oversight), operations (e.g., drone pilots), servicing (e.g., infrastructure maintenance), supply chain management (e.g., hydrogen transport and storage), and regulatory expertise.

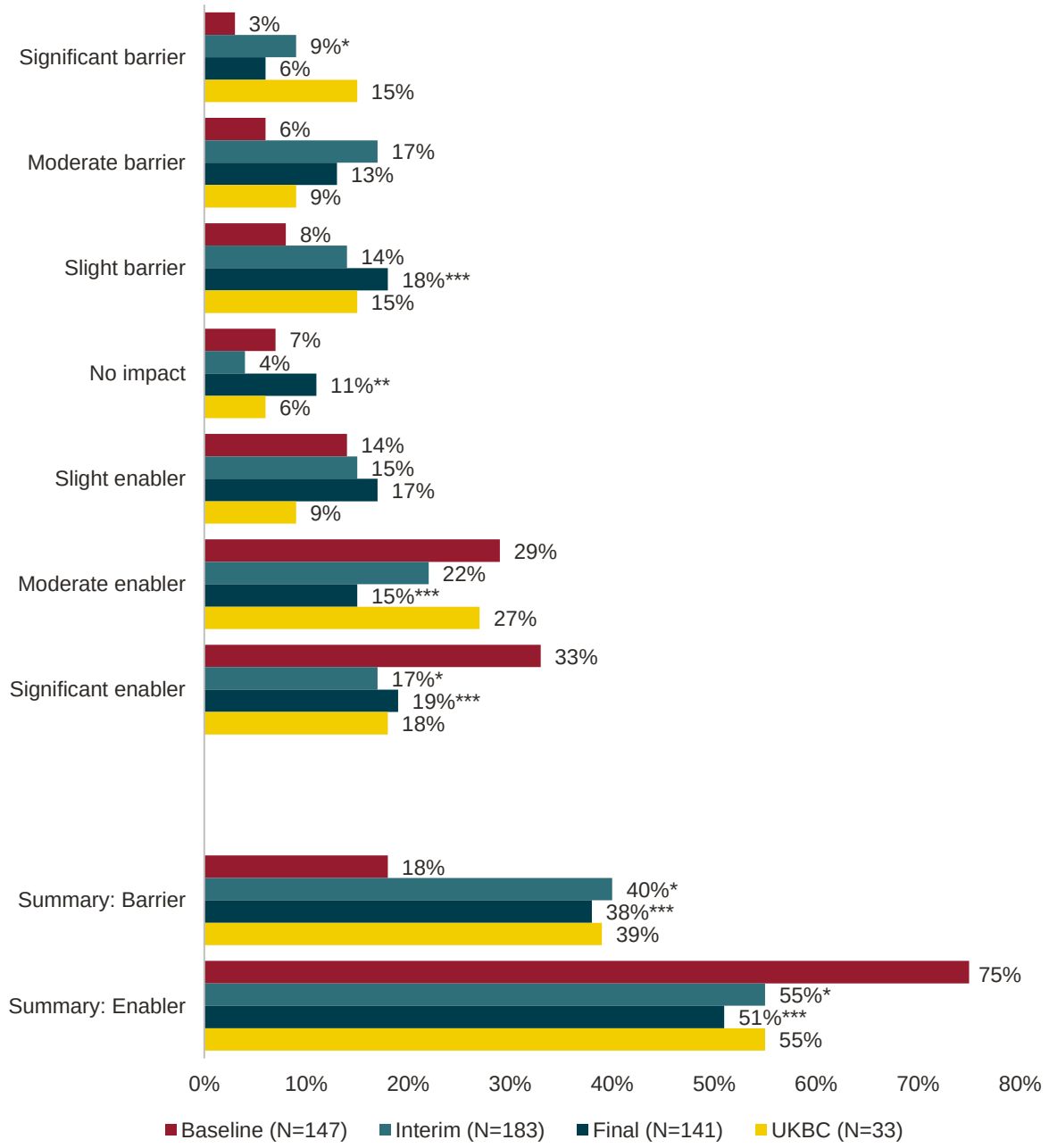
The challenges were reported to be particularly acute for SMEs, which often struggle to recruit specialised talent due to resource constraints and limited capacity for in-house training programmes. However, some local government stakeholders highlighted progress in addressing skill gaps through partnerships with local training providers, enabling the development of customised curricula and apprenticeship programmes to meet the specific demands of the future flight sector.

3.8.3 Evaluation evidence

Figure 37 presents evidence of survey respondents' perceptions of workforce skills as a factor in advancing future flight technology in the UK. While a majority (51%) of final survey respondents viewed workforce skills as an enabler, a notable increase was observed in those identifying it as a barrier compared to the baseline survey (38% vs. 18%). However the perception of skills as a barrier in the final evaluation was similar to the interim evaluation (40%), suggesting there has not been a further deterioration of perceptions. Similarly, UKBC respondents expressed mixed opinions, with a slight majority (55%) considering workforce skills an enabler and 39% perceiving them as a barrier. This highlights the growing recognition of skill gaps as a challenge for the sector's development.

Available FFC project close-out data for the Demonstration Phase indicates that out of 25 respondents from five projects, only three identified a lack of qualified personnel or skills as a barrier to advancing the future flight technology developed within their winning consortia. All respondents reported that the Challenge had helped them acquire at least one new skill or enhance an existing one, with nearly all citing improvements in both technical and strategic skills. However, as there 17 projects funded in the Demonstration Phase, these results are subject to non-response bias.

Figure 37 Extent to which workforce skills are a barrier or an enabler



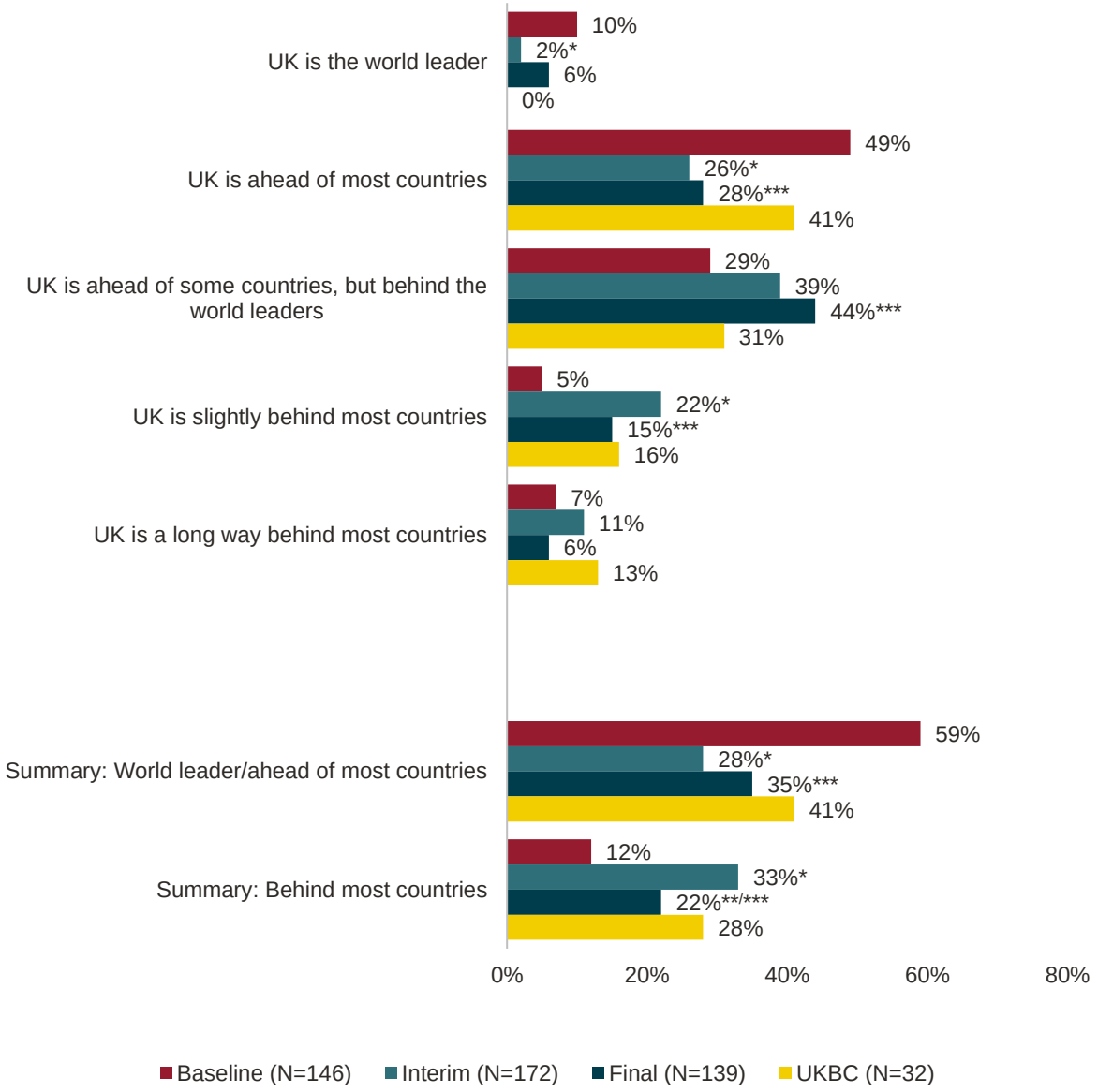
Source: *Industry Survey. C5/6. For each of the following, please indicate whether you think they are a barrier or enabler to the progression of future flight technology in the UK: Skills of the workforce.*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Figure 38 highlights perceptions of the UK's future flight workforce skills compared with other countries. While the proportion of final survey respondents who viewed the UK as lagging behind most countries decreased significantly since the interim survey (22% vs. 33%), it remained higher than the baseline (12%). At the same time, only 35% of respondents considered the UK to be a world leader or ahead of most countries in workforce skills, a notable

decline from 59% in the baseline survey, although slightly improved from the 28% at interim evaluation. These findings suggest a mixed but generally cautious outlook on the UK's comparative position in workforce capabilities within the future flight sector.

Figure 38 UK performance in terms of workforce skills



Source: *Industry Survey. C1/6. I'm now going to read out some elements of future flight technology development and support. For each, please can you tell me how you think the UK is currently performing in comparison to other countries?: Skills of the workforce.*

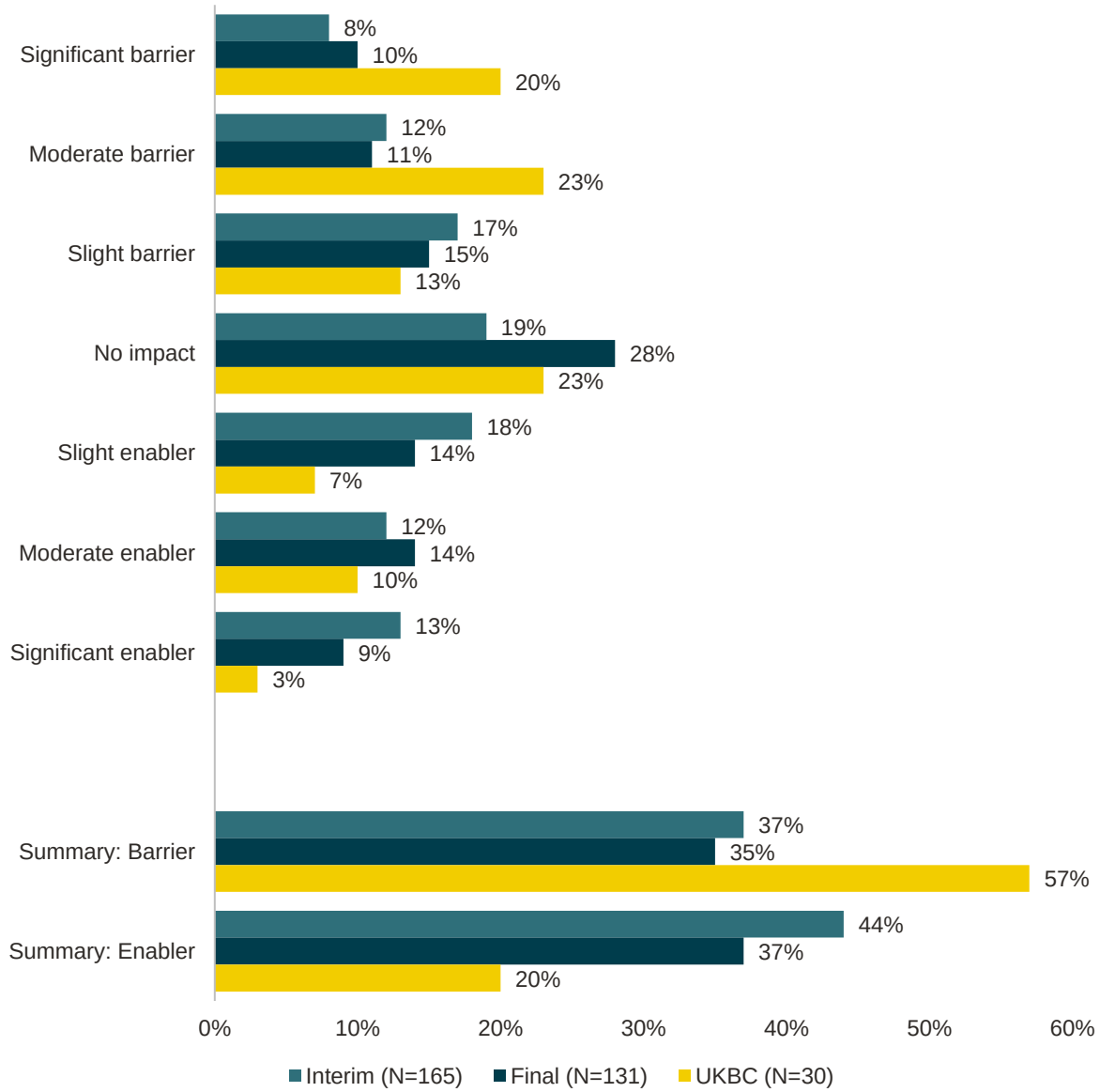
Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

In the interim and final evaluation surveys, perceptions on local authority engagement in future flight technologies were divided. Among final survey respondents, views were evenly split: 35% regarded local authority engagement as a barrier, 37% saw it as an enabler, and 28%

believed it had had no impact. A similar split was seen in the interim evaluation, with no statistically significant differences observed by the final evaluation.

In contrast, UKBC respondents held more critical views, with 57% identifying local authority engagement as a barrier and only 20% considering it an enabler. However, respondents working on physical and digital future flight infrastructure were more optimistic, with 48% and 47%, respectively, saying that local authority engagement supported progress in the sector.

Figure 39 Extent to which local authority engagement is a barrier or an enabler



Source: *Industry Survey. C5/14. For each of the following, please indicate whether you think they are a barrier or enabler to the progression of future flight technology in the UK: Local authorities' engagement.*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

3.9 Theme 8 – Has the Challenge accelerated the formation of economic clusters developing and producing future flight technologies in the UK?

3.9.1 Overview

To assess this evaluation theme, we analysed the metrics summarised in Table 17.

Table 17 Theme 8. Economic clusters – Evaluation metrics

Subtheme	Metric	Data source
Turnover of future flight sector	Value of turnover (GBP) before and after competitions	ONS Business Structure Database, FF monitoring data
	Stated impact of FFC on turnover	Survey data
Employment in the future flight sector	Employment before and after competitions	ONS Business Structure Database, FF monitoring data
	Stated impact of FFC on employment	Survey data
Ratio of additional turnover to UKRI and industry costs	Comparison of additional turnover to FFC costs	Survey data, FFC monitoring data, ONS Business Structure Database

Source: Frontier Economics

Theme 8 – Key messages on economic clusters

- FFC successful participants are experiencing growth and scaling, with an increasing number of micro and small organisations entering the future flight market since the baseline.
- According to survey results, 48% of businesses supported by the Challenge reported a positive impact on their turnover, and 46% said the same about employment.
- The FFC's £100 million investment has generated an estimated £772 million in additional turnover, delivering a significant return on investment and strengthening the UK's future flight sector.

3.9.2 Aims and activities

This evaluation theme focuses on the primary intermediate outcome of the FFC to accelerate the establishment of economic clusters producing future flight technologies in the UK.[46] These clusters represent the main pathway through which the FFC aims to enhance the contribution of the aviation and aerospace sectors to the UK economy by generating additional turnover, employment, and increased exports. However, it is important to note that economic activity driven by the FFC may not always represent net additional gains for the UK, as it could involve a reallocation ("displacement") of resources from other sectors or regions.

At its inception, the FFC anticipated that establishing domestic technology clusters would influence the deployment and specification of future flight technologies. First, commercialising these technologies within the UK speeds up their deployment domestically due to lower transport costs and stronger economic and cultural ties between UK companies and end-users. Second, closer links and feedback loops between UK companies and end-users ensure that domestically commercialised technologies evolve to address UK-specific requirements, including economic, geographic, and infrastructure needs, and government policy priorities. These dynamics highlight the broader impact of the FFC on shaping a competitive and tailored future flight ecosystem in the UK.

3.9.3 Evaluation evidence

Impact of the FFC on UK turnover

Turnover of organisations that have been successful in receiving FFC support was obtained by linking the complete list of successful commercial businesses to the Business Structure Database (BSD) using their Company Registration Numbers (CRN). However, it is important to note that not all of this turnover is necessarily attributed to future flight activities. Indeed, evidence from our industry survey indicates that companies that participated in the Challenge during the Development and Demonstration Phases allocated, on average, 6% of their business to future flight activities. This share remained relatively stable, increasing slightly from 5.9% in the baseline survey to 6.4% in the final survey. [47]

Drawing on the survey findings, we apportioned measured turnover in the BSD for supported companies to future flight activities. This adjustment was made by firm size. In particular, micro and small firms, which tend to be more specialised and focused on niche markets, are likely to allocate a relatively larger share of their business to future flight activities. In contrast, medium and large firms typically have more diversified operations across multiple industries,

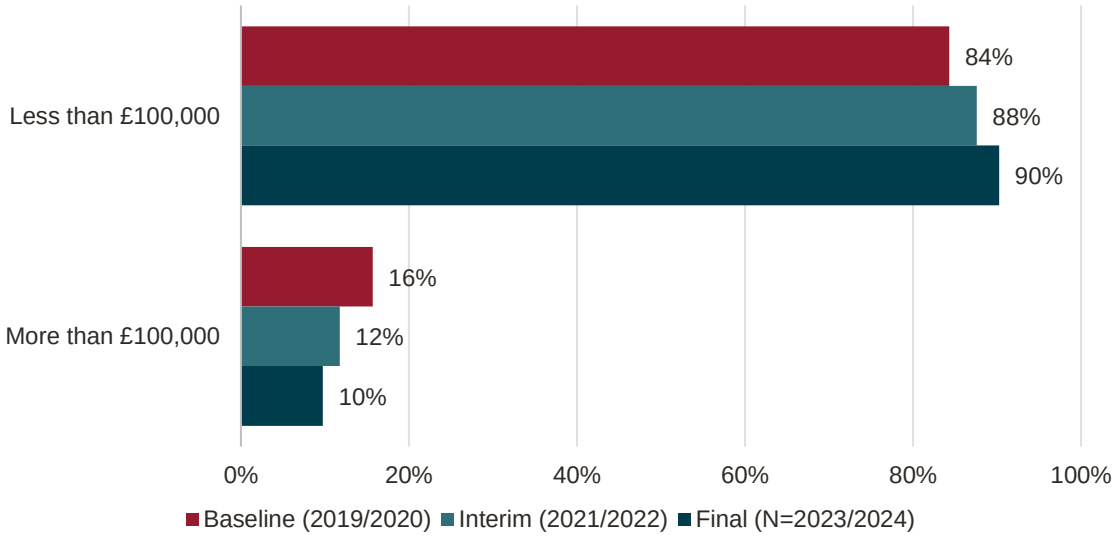
[46] As indicated in the Evaluation Framework, the production of future flight technologies refers to any economic activity directed at developing, operating, manufacturing, coordinating, or selling future flight sector goods and services. This economic activity may be clustered geographically within certain regions of the UK and/or may be clustered into certain sub-sectors within the future flight sector.

[47] Industry Survey. A2A/A2B. Which of these bands would best describe the proportion of your organisation's business that is focused on future flight technologies?

resulting in a lower proportion of their resources being dedicated to a sector. Based on these assumptions and our survey, it is estimated that 8% of turnover in micro firms, 6% in small firms, 5% in medium firms, and 1% in large firms is linked to future flight activities. This is a simplifying assumption and it is likely that the firms supported vary significantly in terms of the actual share of turnover dedicated to future flight. This limitation should be borne in mind in interpreting the findings below.

As presented in Figure 40, the majority of supported organisations (90%) had UK turnover from future flight activities of less than £100,000 in the 2023/2024 financial year. Compared to 2019/2020 figures, the 2023/2024 results highlight a slight decrease in successful organisations in the medium and higher turnover bands. However, this finding is largely driven by micro and small companies entering the market and expanding their presence amongst successful consortia (see Section 3.10).

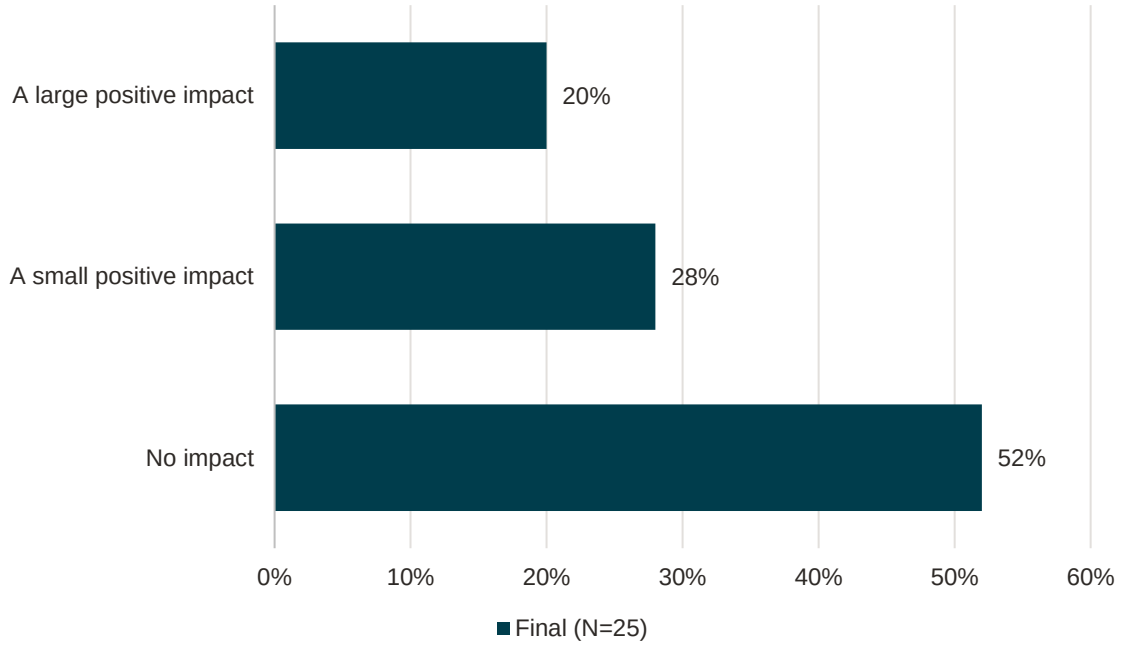
Figure 40 UK future flight turnover in the last financial year



Source: *ONS/BSD, FFC monitoring data*
Note: *Base: 164 successful businesses. UK turnover adjusted by share of the business allocated to future flight activities.*

According to the final survey, nearly half of successful organisations (48%) reported that the FFC had had a positive impact on their UK turnover in the previous financial year. Of these, three in five stated that the impact had exceeded 10%. Across all supported businesses reporting a positive turnover impact, the average increase was 24%. The remaining 52% of successful organisations reported no impact on their turnover.

Figure 41 Stated impact of FFC on UK turnover



Source: *Industry Survey. F5. What impact, if any, do you think the FFC has had on your UK turnover for the previous financial year?*

Note: *Base: valid responses, successful organisations.*

The positive impact on UK turnover was more evident among SMEs, which is consistent with the fact that approximately 70% of successful projects were led by SMEs.[48] In contrast, larger organisations were more likely to report no impact, which can be attributed to their diversified revenue streams and broader portfolios, making the financial contribution of FFC-supported projects a relatively smaller component of their overall turnover. Additionally, larger organisations may require more time to integrate FFC-driven innovations into their existing operations, delaying measurable financial impacts. Conversely, SMEs, often focused on niche markets or emerging technologies, tend to rely more heavily on the projects they lead or participate in. For these smaller organisations, the FFC's funding, networking opportunities, and knowledge sharing initiatives are more likely to produce immediate and tangible benefits, such as new business opportunities, enhanced market visibility, and accelerated growth.

As the commercialisation of future flight technologies is still in its early stages, the full impact of the FFC on UK turnover is expected to take several more years to fully materialise.[49] While the available data is limited and may be influenced by non-response bias, it supports the observed trend of a gradual shift toward higher turnover among businesses in the sector.

48 FFC Project Portfolio Review.

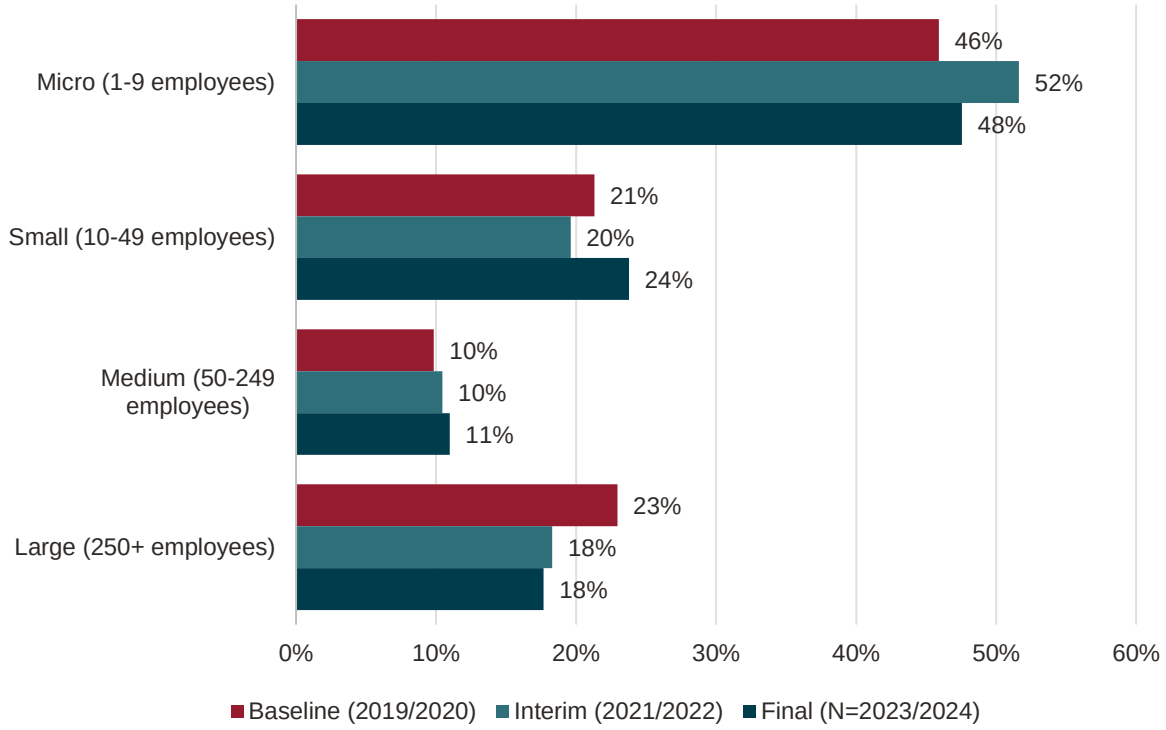
49 The project close-out forms included questions on expected *future* turnover impacts. However, there was a high level of non-response to these questions, meaning that no robust insights could be generated from the data.

Impact of the FFC on UK full-time employment

Consistent with the approach used to analyse turnover levels, employment counts for FFC's successful organisations were obtained by linking the full list of successful organisations to the BSD using their Company Registration Numbers. These employment counts were then adjusted to account for the fact that not all employees in successful firms are engaged in future flight activities, applying the same proportional shares used to adjust turnover levels (with the same associated caveats).

Figure 42 illustrates the share of successful businesses based on their allocation of employees to future flight activities. This distribution remained relatively stable over time, with 48% of businesses assigning between one and nine employees in 2023/2024, a slight increase from 46% in 2019/2020. Small organisations also saw an increase, rising from 21% in 2019/2020 to 24% in 2023/2024. Notably, more than half of supported businesses allocated more than ten employees to future flight activities.

Figure 42 UK full-time employment dedicated to future flight activities in the last financial year



Source: *ONS/BSD, FFC monitoring data*

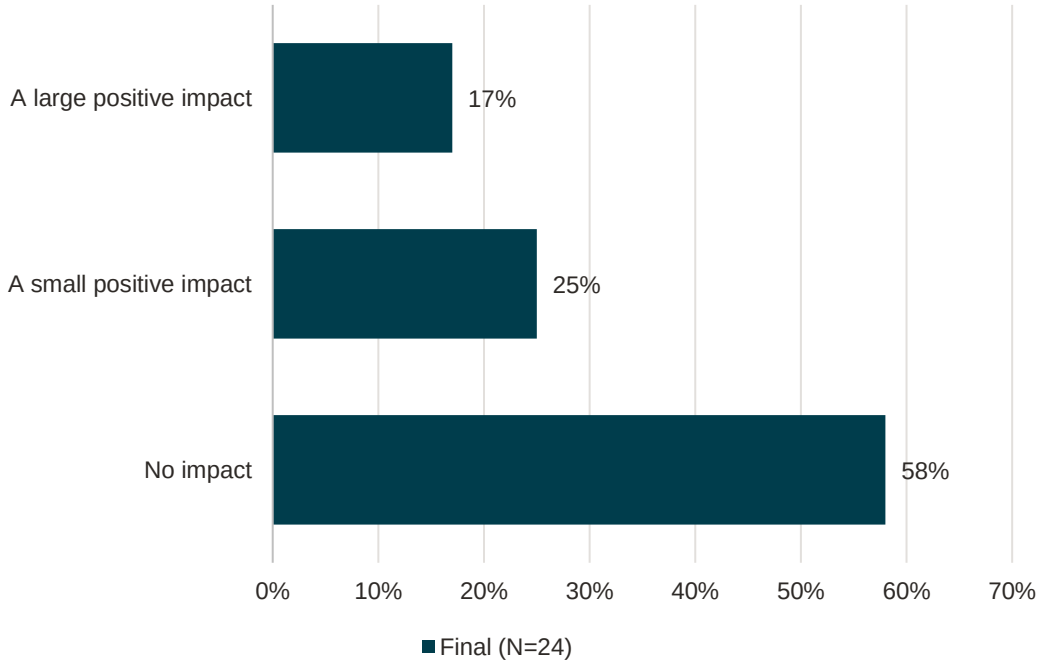
Note: *Base: 164 successful businesses. Firm size ranges calculated based on UK employment counts adjusted by share of the business allocated to future flight activities. Firm size is based on the typical definition used by UK statistical agencies.*

This shift reflects a trend of growth and scaling within the future flight sector, with small and medium companies playing increasingly important roles. These trends highlight the dynamic

and evolving nature of the future flight ecosystem, where businesses of all sizes are adapting to meet the sector's growing demands. This result aligns with figures from the wider future flight sector (see Section 3.12).

According to the final evaluation survey, 42% of successful organisations reported that the FFC had had a positive impact on their UK full-time employment during the previous financial year. Among these, a significant majority (61%) reported an impact exceeding 10%, with an average employment increase of 28% across all respondents reporting a positive impact. The remaining 58% of organisations indicated that the FFC had had no measurable impact on their employment levels.

Figure 43 Stated impact of FFC on UK full-time employment



Source: *Industry Survey. F6. What impact, if any, do you think the FFC has had on your UK full-time equivalent employees at your organisation?*

Note: *Base: valid responses, successful organisations. Figures with asterisks are statistically significant between baseline and interim, and between interim and final at the 95% confidence.*

Ratio of additional UK turnover to FFC costs

This metric is derived using information from the industry survey, BSD, and FFC's monitoring records. During the Development and Demonstration Phases, the Challenge allocated approximately £100 million in grants to support 51 projects involving 151 distinct businesses. Based on information from the BSD, we assume that 74% of supported organisations are SMEs and the rest are large firms. We further used this database and assume that the baseline turnover (2019/2020) dedicated to future flight activities of FFC-supported firms was on average £2 million for SMEs and £336 million for large firms. Based on the final evaluation survey, which reports an average turnover impact resulting from the Challenge of 19% for

SMEs and 6% for large firms, we can therefore estimate that these funded projects have generated approximately £772 million in additional turnover.

This suggests a significant return on the initial investment, although the calculation remains relatively simplistic as it does not account for inflation, discounting, or potential optimism in respondents' attribution of impact to the Challenge. Importantly, it also does not necessarily consider displacement from other non-future flight revenue or domestic competitors not supported by the Challenge. The figure should therefore be treated cautiously and as a likely upper bound.

Furthermore, additional turnover does not directly translate to increased economic activity, which is more accurately measured by the additional gross value added (GVA) associated with this turnover. Identifying the relevant economic activities within the future flight sector is crucial for this assessment, with a more detailed analysis presented in Section 3.12. However, taking a conservative approach and focusing only on activities linked to the traditional aviation and aerospace sectors (as outlined in Table 22, Section 3.12), data from the Annual Business Survey (ABS) suggests a GVA-to-turnover ratio of approximately 1:3. Based on this, the estimated additional GVA from FFC-supported projects is around £400 million, with the same caveats on the estimate as highlighted above.

3.10 Theme 9 – Has the Challenge helped to encourage a diverse future flight sector?

3.10.1 Overview

To assess this evaluation theme, we analysed the metrics summarised in Table 18.

Table 18 Theme 9. Diversity – Evaluation metrics

Subtheme	Metric	Data source
Distribution of successful organisations	Count, turnover, and employment of successful organisations by size, SIC, and region	Survey data/FFC monitoring data/ONS Business Structure Database
Workforce diversity of winning consortia leads	Share of workforce that is female/non-binary	Survey data

Source: Frontier Economics

Theme 9 – Key messages on diversity

- The future flight sector features a predominance of micro and small businesses, although larger firms are over-represented among successful FFC participants compared to the UK average. There is some evidence of growth and scaling within FFC-supported businesses.
- Many FFC grant applicants come from diverse industries such as software development, IT consultancy, and research, reflecting the multidisciplinary nature of the future flight sector beyond traditional aerospace activities.
- 28% of successful organisations are headquartered in London, while 20% are in South East England and 15% in South West England.
- The representation of female and non-binary employees in R&D roles has improved among FFC participants, although diversity gaps remain a challenge within the sector.

3.10.2 Aims and activities

The FFC actively supports diversity within the future flight sector, focusing on enhancing workforce inclusion and integrating a broad range of UK companies into the industry. A cornerstone of this effort is fostering collaboration among diverse organisations, ensuring that multiple perspectives and expertise are leveraged to align with the FFC's broader diversity objectives.

To achieve this, the FFC required applicants to form large, diverse consortia for competitions. For both the Development and Demonstration Phases, project leads were required to include at least one registered SME or be an SME themselves. Depending on the competition strand, the FFC also required or encouraged consortia to include end-users, operators, and local authorities, ensuring comprehensive stakeholder involvement and practical applicability.

During the Demonstration Phase (2022-2025), the FFC co-founded the Future of Air Mobility Accelerators, six-month programmes delivered by CPC. This programme supported ten SMEs in trailing disruptive innovations in the aviation sector. In addition, to access funding for trials and testbeds, participating SMEs received investment readiness support, technology and product development guidance, and introductions to potential customers through partnerships with CPC and the FFC.

During the Development Phase (2021-2022), the FFC also surveyed projects to determine whether their technologies or services could benefit protected groups. Several projects highlighted the potential of automation, such as drone-operated tasks, to diversify the workforce. For example, infrastructure inspections, traditionally performed by male workers due to physical demands, could be conducted remotely. This shift would enable individuals with disabilities, older workers, and women to take on these roles, fostering a more inclusive workforce within the future flight sector.

Additionally, the FFC has supported strategic initiatives aimed at improving equality, diversity, and inclusion across the sector workforce. For instance, in 2023, the FFC launched a mentoring scheme to support women in the aviation sector. The scheme provides mentees and mentors with a communications network, sharing key information and offering dedicated support through workshops, events, and an online mentoring platform.

3.10.3 Evaluation evidence

Distribution of successful businesses by firm size

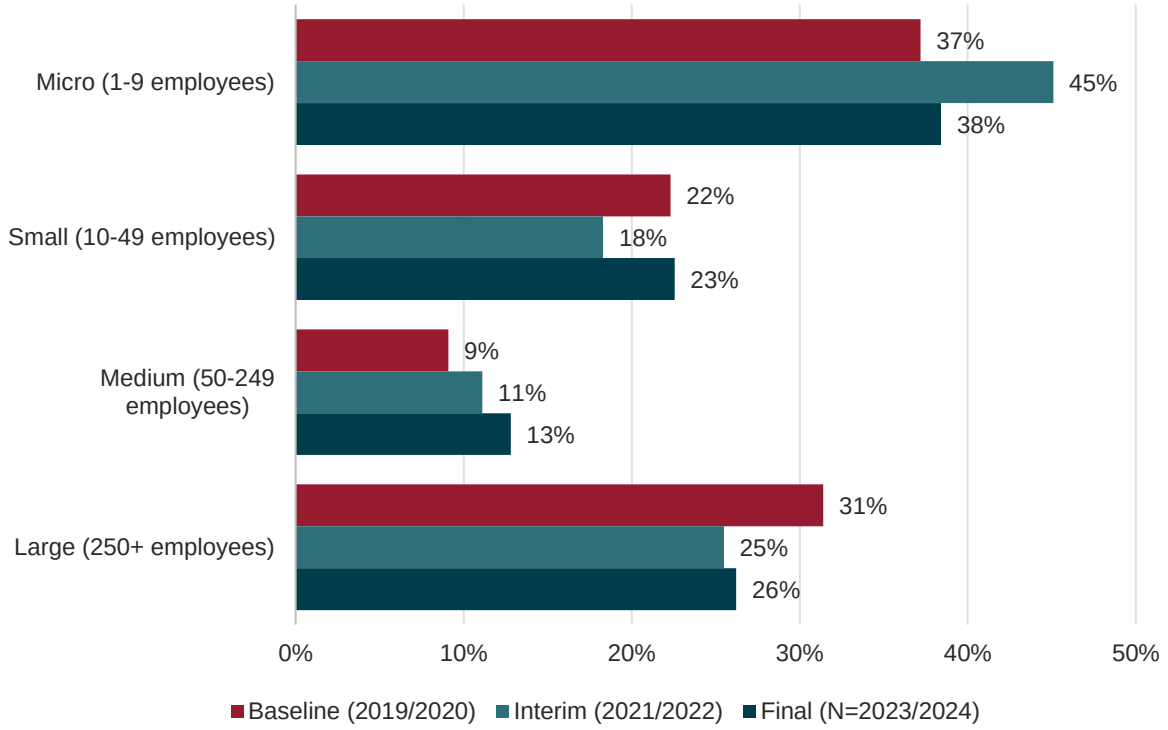
The assessment of the distribution of successful businesses by firm size, industry, and region used information from the BSD. Consistent with the approach taken in Section 3.9 and Section 3.12, the complete list of successful business was linked to this dataset using their Company Registration Number.

The distribution of organisational size among successful businesses, as shown in Figure 44, indicates a predominance of microbusinesses (1–9 employees), alongside a growing share of small and medium enterprises. Thirteen percent of respondents were medium-sized businesses, up from 9% in 2019/2020. Meanwhile, large organisations (250+ employees) accounted for 26% in 2023/2024, down from 31% in 2019/2020, yet still significantly above the UK average of less than 1%.[50] As discussed in Section 3.9.3, the overall size of supported firms likely includes employees who are not dedicated to future flight activities.

These trends highlight the strong presence of smaller firms among successful businesses while also revealing an over-representation of larger firms. Additionally, the increasing share of medium-sized businesses suggests evidence of growth and scaling within FFC-supported businesses. The over-representation of larger organisations among successful FFC applicants highlights the Challenge's emphasis on fostering collaborations across a range of business sizes. While micro and small firms remain a core focus, the inclusion of medium and large organisations brings additional resources, expertise, and capacity to the projects, creating opportunities for cross-sector collaboration.

50 ONS. Business population estimates for the UK and regions 2024

Figure 44 Distribution of successful businesess by firm size



Source: *BSD and FFC monitoring data*

Note: *Base: 164 successful businesses. Information is presented for successful businesses only. Firm size is based on the typical definition used by UK statistical agencies.*

Distribution of successful businesses by industry

Table 19 presents the top ten most common SIC codes among successful businesses, highlighting the diversity of the sector. While some SIC codes align with traditional aerospace and aviation activities, a significant portion represent industries focused on software development, IT consultancy, research, and professional services. This indicates that many successful applicants were not from the most conventional aerospace sector but instead from supporting industries integral to the future flight ecosystem. The representation of such varied activities underscores the multidisciplinary nature of the future flight sector, incorporating expertise in technology, operations, and management alongside traditional aerospace capabilities.

Table 19 Top 10 SICs among successful businesses

Code	SIC description
62012	Business and domestic software development
30300	Manufacture of air and spacecraft and related machinery

Code	SIC description
62020	Information technology consultancy activities
72190	Other research and experimental development on natural sciences and engineering
52230	Service activities incidental to air transportation
71129	Other engineering activities
85421	First-degree level higher education
70229	Other management consultancy activities
74909	Other professional, scientific and technical activities
62090	Other information technology service activities

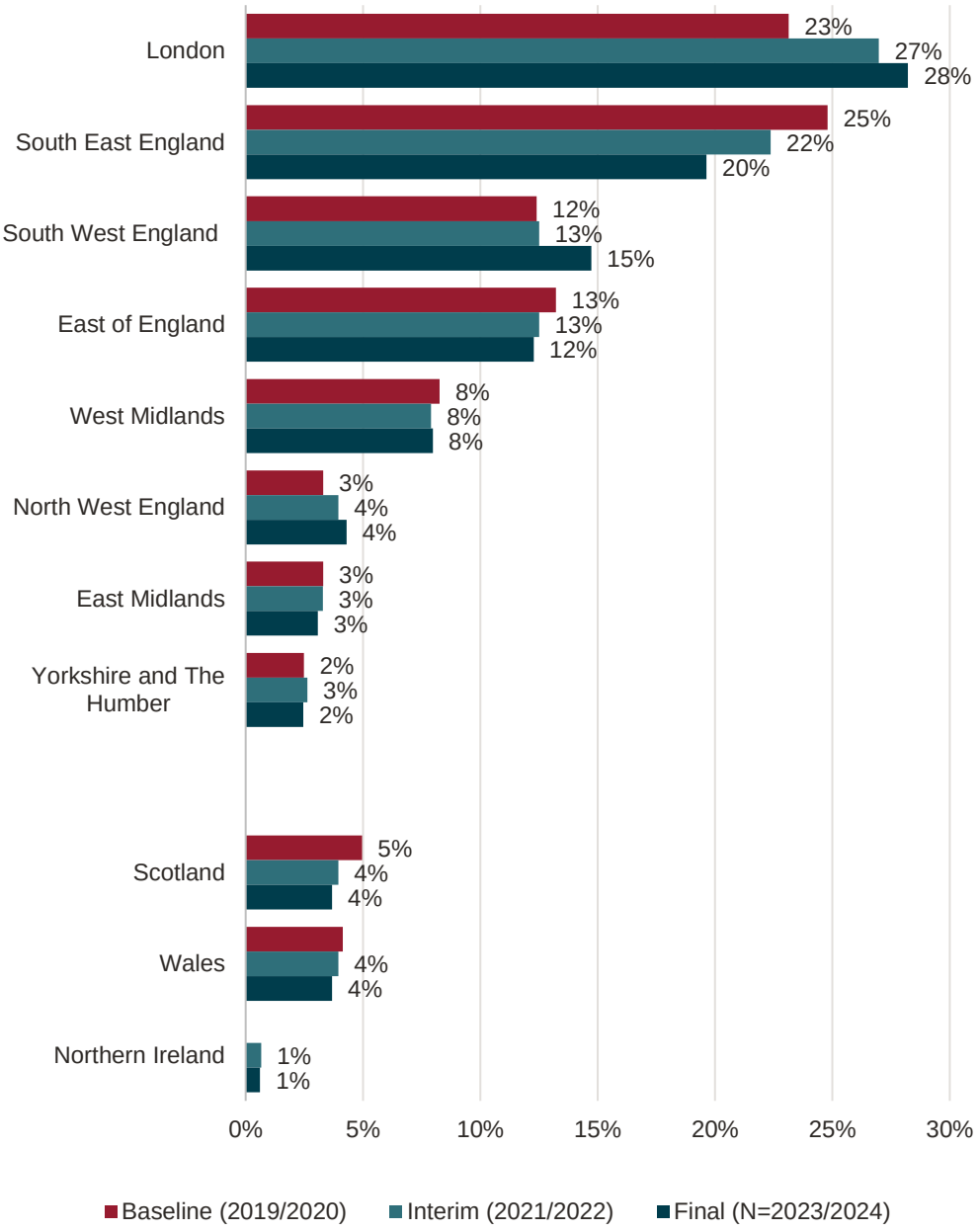
Source: BSD, FFC monitoring data

Distribution of successful businesses by region

Figure 45 shows the regional distribution of successful organisations' headquarters across the UK, based on FFC monitoring data. The distribution has remained relatively stable over time, with 28% of respondents headquartered in London based on the final evaluation sample. Additionally, 20% and 15% of businesses reported being based in South East England and South West England, respectively. Businesses operating in devolved nations represent a smaller proportion of FFC's successful participants. This regional distribution broadly aligns with the overall regional concentration of businesses in the UK, although both London and the South East are over-represented among FFC participants.[51]

[51] ONS. Business population estimates for the UK and regions 2024

Figure 45 Regional distribution of successful businesses



Source: *FFC monitoring data*
Note: *Base: 151 successful businesses.*

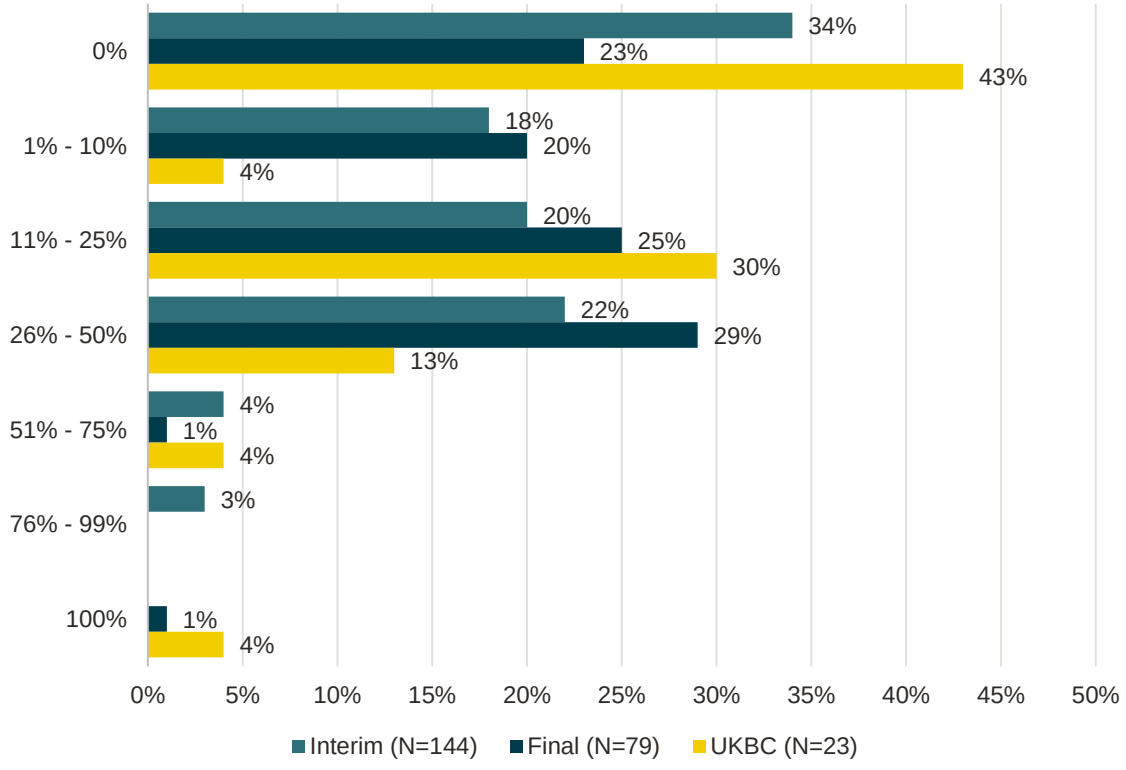
There is evidence from case studies that the CAA has also been able to support new companies that are unfamiliar with aerospace regulations, fostering a more inclusive ecosystem. By bringing together diverse stakeholders, the FFC has enhanced communication and interaction between the regulator and new entrants in the future flight sector, allowing the regulator to better understand the needs and challenges of various operators and make more informed regulatory decisions.

"One important point of UK is they are very strong in simplifying communication for new players in the drone domain…because we need to adapt our communication to companies that are not familiar with aviation jargon." - Regulator

Workforce diversity of winning consortia leads

Figure 46 highlights the presence of female and non-binary employees specifically within R&D staff, comparing results from the interim and final surveys as well as UKBC respondents. Between the interim and final surveys, there is a noticeable reduction in the proportion of organisations with no female or non-binary R&D staff, decreasing from 34% to 23%. Additionally, there is a modest increase in organisations reporting higher representation of female and non-binary employees in R&D roles. This suggests that, at least among FFC-supported firms which responded to the survey, there has been a shift towards a more gender-diverse R&D workforce.

Figure 46 Presence of female/non-binary R&D staff



Source: *Industry Survey. A6D. Approximately what proportion of the full-time R&D staff at your organisation identify as female or non-binary?*

Note: *Base: valid responses. Figures with one asterisk are statistically significant between baseline and interim, two asterisks between interim and final, and three asterisks between baseline and final at the 95% confidence level.*

Interestingly, UKBC respondents, who represented companies not directly engaged with FFC competitions, show a higher proportion (43%) with no female or non-binary R&D staff, suggesting that FFC participants generally demonstrate greater gender diversity. Despite this, the overall data reveals persistent under-representation of female and non-binary employees

in R&D roles, underscoring the ongoing need for initiatives to improve diversity within the sector.

3.11 Theme 10 – Has the Challenge accelerated the deployment of future flight technologies in the UK, leading to economic and social benefits?

3.11.1 Overview

To assess this evaluation theme, we analysed the metrics summarised in Table 20.

Table 20 Theme 10. Wider economic and social benefits – Evaluation metrics

Subtheme	Metric	Data source
Contribution towards net zero from future flight technologies	Extent to which future flight technologies were developed to meet UK use cases and environmental targets	Case studies
Benefits and costs from future flight technologies	Estimation of user and non-user potential benefits and costs	Rapid literature review
Economic benefits from new aviation services	Estimation of potential economic benefits	Rapid literature review

Source: Frontier Economics

Theme 10 – Key messages on wider economic and social benefits

- Evidence from case studies shows that the FFC has enabled demonstrations of low-emission technologies (e.g., drones, eVTOLs), replacing carbon-intensive vehicles with zero-emission solutions, improving both operational efficiency and public perception.
- There is evidence that these demonstrations have improved how the wider sector understands the environmental impact of future flight technologies and have informed commercial business cases to expand UAS operations.
- Stakeholders interviewed recognised the FFC's role as a "technology enabler", although some felt its focus was more on enabling technologies than directly achieving net zero outcomes. Therefore, it is too soon to assess the contribution of the Challenge towards achieving the UK's net zero targets.
- Ongoing challenges identified by stakeholders were regulatory barriers, infrastructure readiness, and the ability to comprehensively assess the lifecycle environmental impact of future flight technologies.

- The rapid literature review found that future flight technologies have the potential to offer benefits such as reduced carbon emissions, improved operational efficiency, and safety gains, but also might present costs related to battery production, electricity grid emissions, infrastructure requirements, and potential social impacts like noise pollution and equity concerns.

3.11.2 Aims and activities

The FFC aims to influence the deployment and specification of future flight technologies to meet the UK's specific requirements, creating positive spillovers such as economic, social, and environmental benefits. This ambition is rooted in delivering increased mobility, reducing transport emissions, and ensuring broader societal gains. By aligning advanced technologies with UK needs, the FFC has anticipated significant outcomes, such as improved public health, wellbeing, and environmental sustainability. From its inception, the FFC has aimed to accelerate these outcomes by fostering innovation and ensuring that the sector evolves sustainably. The full realisation of these benefits is anticipated to become evident from 2025 onwards.

In the absence of the Challenge, it was expected that the economic and social benefits of future flight technologies would likely materialise at a slower pace and with less alignment to UK-specific needs. However, the environmental impact of FFC remains uncertain. If supported projects lead to the creation of new energy-intensive services, its effects may be negative, but if they displace existing services with cleaner alternatives, its effects may be positive. Ultimately, the FFC's role is to amplify positive environmental impacts by accelerating the deployment of sustainable technologies and mitigating potential negative effects by promoting the development of environmentally friendly innovations that might not otherwise have been prioritised.

In the interim evaluation, stakeholders indicated that, while alignment of the FFC with initiatives related to transport and aviation is well established, there is less clarity about its alignment with net zero.

3.11.3 Evaluation evidence

Contribution towards UK net zero target

In 2021, the UK set out a Net Zero Strategy, building on a set of policies and proposals to help decarbonise all sectors of the UK economy by 2050.[52] According to this strategy, transformation across all sectors will require significant investment and technology advancement to meet the UK's target. At the time, it was estimated that the aviation sector would play a small role in achieving this target, compared with other sectors such as domestic transport which had the largest share of UK greenhouse gas emissions across the UK

[52] BEIS (2021) Net Zero Strategy: Build Back Greener

economy. However, stakeholders interviewed considered that this presents an opportunity for the sector to "lead by example", inspiring other sectors to accelerate their initiatives.

In case study interviews, respondents noted that, prior to the launch of the Challenge in 2019, some companies in the sector had developed vision statements around net zero technologies, but there was little clarity on timelines for achieving operational deployment, and the focus was often on end-user benefits rather than environmental impacts. Organisations such as the Aerospace Technology Institute focused on providing support for sustainable future flight technologies through funding and programme initiatives. However, regulatory barriers significantly hindered the ability to demonstrate and quantify the environmental advantages of new air vehicles. As a result, there was an insufficient understanding of the unique advantages that future flight technologies could deliver to the environment.

According to stakeholders, the FFC has addressed these gaps by enabling demonstrations of future flight technologies, helping to unlock their potential for sustainable operations and reduced carbon emissions. Demonstrations under the Challenge have included emergency deliveries of essential medicine, clinical supplies and blood packs in Scotland(NHS), and parcel deliveries in the Orkney Islands (UK Royal Mail), which replaced carbon-intensive ground vehicles with lower emission delivery solutions using drones. These technologies, primarily powered by batteries or hydrogen, have zero operational emissions compared to traditional vehicles. For instance, a UAS or eVTOL operating over a 100-mile distance produces zero emissions, whereas a comparable diesel-powered vehicle generates approximately 33 kilograms of CO_2.

> *"A method of taking cars off the road by instead using zero-carbon emissions will directly impact zero emissions and local air quality." – Industry stakeholder*

Stakeholders highlighted that ongoing technology demonstrations have improved their understanding of potential carbon emission reductions. While the FFC's use cases have demonstrated promise in reducing Scope 1 and 2 emissions,[53] these represent only a small segment of a broader ecosystem, underscoring the need for further evaluation of their full lifecycle environmental impact. Stakeholders emphasised that quantifying these environmental impacts would require clearly defining the boundaries of the future flight sector, including its scope in terms of technologies and use cases. Furthermore, a significant gap remains in conducting quantitative assessments to accurately model and evaluate the wider benefits of scaling these technologies across organisations' extensive operations.

> *"We now have a strong understanding of what the impact of hydrogen looks like." – Industry stakeholder (SME)*

Additionally, discussions with the Challenge's participants indicated that the demonstrations of UAS flight operations had helped them gain traction with senior leadership and had informed commercial business cases to expand their UAS fleet to achieve further net zero benefits. One

[53] Greenhouse gases that are released across an organisation's entire value chain.

stakeholder mentioned that their organisation was planning to reduce crewed aircraft operations that used standard jet fuel by 50% in part due to the successful performance of their UAS demonstrations. However, interviews suggested conflicting priorities, particularly among large organisations, where the primary focus remains on enhancing operational efficiency and accessing new markets and end-users, with environmental impact often taking a secondary role.

The FFC has also played an important role as a "technology enabler" helping to break down barriers to adoption by fostering collaboration between stakeholders, advancing technology readiness, and addressing regulatory challenges. Stakeholders described the Challenge as an "icebreaker" that has paved the way for innovations such as hydrogen propulsion and airspace integration for next-generation aircraft. The FFC has not only provided the financial and strategic support needed to develop and demonstrate these technologies but has also allowed organisations to share their success stories on a global platform, improving the perception of future flight technologies and their alignment with net zero goals.

Despite these successes, challenges remain in fully quantifying the environmental benefits of future flight technologies. While the operational benefits of zero-emission systems are clear, organisations highlighted the need for a comprehensive assessment of the entire value chain of these technologies, including manufacturing, infrastructure, and end-of-life impacts. Additionally, some stakeholders felt that the Challenge's focus had been more on enabling technologies than on driving net zero outcomes directly, with many advancements attributed to organisational goals rather than the Challenge itself. To unlock the sector's potential, stakeholders suggested that future programmes would need to place greater emphasis on quantifying net zero benefits, scaling up operations, and addressing infrastructure requirements such as charging stations and refuelling points.

> *"[Future flight technologies] might be used to support net zero targets in the future, but right now, the sort of demonstrations we are involved in are not going to dramatically support net zero." – Industry stakeholder*

Benefits and costs for users and non-users of future flight technologies

This section provides an assessment of the potential benefits and costs of future flight technologies for both users and non-users, drawing on insights from a rapid literature review. As such, it does not aim to offer conclusive evidence regarding the contribution or additionality of FFC, but rather to outline key findings and considerations based on existing research.

As emphasised by stakeholders interviewed, the uncertainty surrounding the development and adoption of future flight technology makes it challenging to accurately predict its benefits and costs. The UK Department for Transport (2024) has described them as "unquantified".[54] However, there is a limited but growing body of research exploring the potential social and environmental effects that may arise as these technologies develop and integrate into society.

[54] Department for Transport. (2024, October 22). Benefits of airspace modernisation.

Chief among these from an environmental perspective are emissions reductions from the electric propulsion technology found in eVTOLs and drones. Such aircraft produce zero operational (and therefore local) emissions (Uber, 2016).[55] Moreover, where renewable energy can be used, this reduction in emissions is not limited to the area of use, and a report published by PwC (2023) found that future flight technologies could reduce carbon emissions in the UK by 222 million tons of CO_2e per year by 2040,[56] the equivalent of over £24 billion in monetary value to society based on UK government guidance on carbon valuation (Department for Energy Security & Net Zero, 2024).[57]

Future flight technologies are also expected to deliver safety benefits. Stakeholders often compare their safety standards to those of the aviation industry, which are higher than the safety standards currently applied to ground transportation (Royal Aeronautical Society, 2024).[58] It follows that AAM would be safer for users than traditional modes of transport:

- **For passengers**, Uber (2026) has set a goal for eVTOLs to be twice as safe as driving, measured by fatalities per passenger-kilometre. Similarly, the European Union Aviation Safety Agency (EASA, 2021) has highlighted that urban air transport could be approximately 1,500 times safer than road transport if it matched the safety standards achieved by aviation in the EU in 2018.[59]
- **For pilots and crew**, advanced pilot autonomy systems and sense and avoid technologies may increase safety levels in the near term for non-passenger-carrying use cases (Chappelle, Li, Vascik, & Hansman, 2018).[60]
- **For non-users**, however, there are outstanding questions related to the risks of eVTOL use in urban areas and an acknowledgement that more research is needed in this area (De Souza Borges, Machado Cardoso Junior, & Silva Castilho, 2022).[61]

Other benefits may emerge as a result of new use cases of future flight technologies. Studies have investigated the use of eVTOLs in the provision of emergency medical services, finding that this may bring efficiency and safety gains, with the highest marginal benefits found in the rural areas that are most difficult to access with traditional modes of transport (Chappelle, Li, Vascik, & Hansman, 2018; Goyal & Cohen, 2022). [62] Using future flight technologies for bridge inspections may save time for car passengers (due to reduced road closure time) and reduce

55 Uber. (2016). Fast-Forwarding to a Future of On-Demand Urban Air Transportation.

56 PwC. (2023). Advanced Air Mobility: UK Economic Impact Study.

57 Department for Energy Security & Net Zero. (2024). Traded carbon values used for modelling purposes.

58 Royal Aeronautical Society. (2024). Shaping the Future of Advanced Air Mobility Safety.

59 EASA. (2021). Study on the societal acceptance of Urban Air Mobility in Europe.

60 Chappelle, C. A., Li, C., Vascik, P. D., & Hansman, R. J. (2018). Opportunities to Enhance Air Emergency Medical Service Scale through New Vehicles and Operations. *Aviation Technology, Integration, and Operations Conference*.

61 De Souza Borges, S. F., Machado Cardoso Junior, M., & Silva Castilho, D. (2022). Safety Analysis of eVTOL Landing in Urban Centers. *Proceedings of the 32nd European Safety and Reliability Conference.* Singapore.

62 Goyal, R., & Cohen, A. (2022). Advanced Air Mobility: Opportunities and Challenges Deploying eVTOLs for Air Ambulance Service. *Applied Sciences, 12*(3), 1183.

safety risks for inspectors themselves (Dulia, Sabuj, & Shihab, 2022).[63] In the UK, Essex Police have trialled the use of drones for imaging, demonstrating that these technologies can contribute to effective policing (Fox, 2019).[64]

As with any new technology, there are also likely to be associated social and environmental costs. While local emissions from electric air travel are negligible, overall measures of emissions must also consider electricity production (i.e., grid emissions) and the CO_2 associated with production of, for instance, lithium-ion batteries. For example, a study found that eVTOL travel would currently result in lower overall emissions in Chicago but higher overall emissions in Dallas, where electricity grid emissions are higher (Mudumba, Chao, Maheshwari, DeLaurentis, & Crossley, 2021).[65] Another study of delivery systems also found that emissions reductions would be offset by the growing prevalence of electric vans that would otherwise be more efficient anyway (Perez, Zou, & Farazi, 2025).[66] Further environmental considerations and challenges relate to the eventual disposal of electric batteries used in electric propulsion aircraft (NASA, 2018).[67]

Non-users may be faced with novel noise and visual pollution, as well as increased road traffic around vertiports, the potential levels of which remain unclear. This is a concern underlined by the potential for large numbers of aircraft that may be needed to establish effective logistics or passenger-carrying networks (McNab, 2024).[68] Uber (2016) proposed a localised approach to dealing with this, restricting traffic to each vertiport such that noise changes do not reach perceptible levels.

An additional but important risk for future flight technologies is their impact on equity. That is, if AAM systems are designed with only their users in mind, the benefits they enjoy may come at the cost of non-users (McNab, 2024). These concerns would in turn be exacerbated if affordability rules out use for less wealthy individuals (EASA, 2021).

Economic benefits and costs of future flight technologies

As above, this section examines the potential economic benefits and costs associated with future flight technologies, leveraging insights from a rapid literature review. Rather than providing definitive evidence of the FFC's contribution or additionality, it aims to highlight key findings and considerations based on existing studies.

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63 Dulia, E. F., Sabuj, M. S., & Shihab, S. A. (2022). Benefits of Advanced Air Mobility for Society and Environment: A Case Study of Ohio. *Applied Sciences, 12*(1), 207.

64 Fox, S. J. (2019). Policing - The technological revolution: Opportunities & challenges! *Technology in Society, 56*, 69-78.

65 Mudumba, S. V., Chao, H., Maheshwari, A., DeLaurentis, D. A., & Crossley, W. A. (2021). Modeling CO2 emissions from trips using urban air mobility and emerging automobile technologies. *Transportation Research Record, 2675*(9), 1-14.

66 Perez, D., Zou, B., & Farazi, N. P. (2025). Package delivery by electric vertical takeoff and landing aircraft? An attractiveness assessment. *Journal of Air Transport Management, 124*.

67 NASA. (2018). Urban Air Mobility (UAM) Market Study.

68 McNab, R. M. (2024). Advanced Air Mobility, Economic Impacts, and Equity Considerations. *Journal of Economic Analysis, 3*(2), 61.

Many of the anticipated economic benefits of future flight technologies are dependent on technological advancements and the development of use cases that have yet to materialise. Existing research has, however, sought to identify potential future impacts on the economy. Users of future flight technologies will benefit from reduced travel time due to faster, more direct routes, but the associated productivity would also be passed through as a wider economic benefit that outweighs the costs (Dulia, Sabuj, & Shihab, 2022). As a white paper by Uber (2016) has pointed out, these benefits could be particularly large given the large amount of (unproductive) time spent commuting globally; it estimates that a commute from Gurgaon to central New Delhi could be cut from 1 hour 40 minutes by car to just 6 minutes by VTOL.

Non-users may benefit in other ways. The use of eVTOLs and drones is expected to significantly reduce costs in various sectors, including package delivery, cargo transport, and agriculture, and some of these savings would be passed onto consumers (Dulia, Sabuj, & Shihab, 2022). In the UK, £22 billion in net cost savings are predicted as a result of the use of drones by 2030 (PwC, 2022).[69] The logistics industry is often cited in this regard, with research finding that already existing technology could deliver cost savings through a combination of eVTOL and van-based delivery (Perez, Zou, & Farazi, 2025; Sudbury & Hutchinson, 2016).[70]

Job creation related to the future flight industry is expected to make a significant contribution to the economy, both in the UK and worldwide. In its 2022 report, “Skies without limits v2.0”, PwC estimated that drones alone could contribute up to £45 billion to the UK economy by 2030. In addition, it predicted that over 650,000 jobs may be associated with the drone economy, including a combination of new jobs and adaptations to existing ones.

Uncertainty related to future flight technologies means that the associated economic costs are likely to be – at least in part – unforeseeable. In the short term, work in this area points to high initial costs that are necessary to overcome the barriers to widespread rollout of future flight technologies. It includes infrastructure costs such as the need to establish a critical mass of vertiports for the use of eVTOLs (NASA, 2018), as well as the costs of developing appropriate regulatory frameworks and standards (CAA, 2021).[71]

However, in the long run, structural changes to the economy could bring additional costs related to specific use cases. In the logistics industry, where some of the greatest impacts are expected, delivery driver jobs may be replaced by autonomous methods of delivery (Wandelt, Wang, Zheng, & Sun, 2024). Although somewhat speculative, equity considerations are again relevant: McNab (2024) argued that close proximity to vertiports is likely to add a negative drag to house prices and that impacts such as these must be fairly distributed.

69 PwC. (2022). Skies Without Limits v2.0.

70 Sudbury, A. W., & Hutchinson, E. B. (2016). A cost analysis of Amazon Prime Air (drone delivery). *Journal for Economic Educators, 16*(1).

71 CAA. (2021). Advanced Air Mobility: Taking a Use Case Approach to Develop Regulation.

Governments and researchers alike highlight the importance of a well-considered approach to future flight technologies that minimises social, environmental, and economic costs but maximises benefits: the development of a national AAM strategy, work on regulatory developments, and continued public and private funding are all important in this regard (BryceTech, 2023).[72]

3.12 Theme 11 – Has the Challenge increased the contribution of the aviation and aerospace sectors to the UK economy?

3.12.1 Overview

To assess this evaluation theme, we analysed the metrics summarised in Table 21.

Table 21 Theme 11. Contribution of future flight sector to UK economy – Evaluation metrics

Subtheme	Metric	Data source
Size of the future flight sector in the UK	Number of companies in the aviation and aerospace sectors	ONS Business Structure Dataset
	Turnover of the aviation and aerospace sectors	ONS Business Structure Dataset
	Employment of the aviation and aerospace sectors	ONS Business Structure Dataset
	GVA of aviation and aerospace sectors	ONS Annual Business Survey aggregates
Contribution of future flight sector to the UK economy		ONS Business Structure Dataset, ONS Annual Business Survey aggregates

Source: Frontier Economics

[72] BryceTech. (2023). Advanced Air Mobility: An Assessment of a Coming Revolution in Air Transportation and Logistics. Department for Transport.

Theme 11 – Key messages on contribution of aviation and aerospace sectors to UK economy

- Recent trends show a decline in smaller firms, while medium-sized businesses are growing, indicating industry consolidation.
- The sector's strength lies in its diverse activities, including consultancy, technology, and manufacturing, highlighting the importance of a broader ecosystem beyond traditional aviation and aerospace economic activities.
- The future flight sector significantly contributes to the UK economy, representing approximately 4.8% of total private sector turnover, comparable to established industries like construction and information technology.

3.12.2 Aims and activities

The ultimate long-term objective of the FFC is to increase the contribution of the aviation and aerospace sectors to the UK economy, through a range of channels such as increased turnover, creating higher employment levels, improving pay and productivity, and expanding exports of goods and services to international markets.

Industrial benefits from the FFC are largely driven by the establishment of future flight technology clusters, which serve as hubs for innovation and commercialisation. However, significant spillovers also arise from the five immediate outcomes of the FFC, independent of these clusters, such as improved public health, wellbeing, and environmental sustainability (see Section 3.11).

The aviation and aerospace sectors encompass a wide range of activities beyond the future flight sector, including the manufacturing and repair of aircraft and related equipment, passenger and freight air transport operations (both scheduled and unscheduled), aircraft leasing, and ancillary services. Given this broad scope, it was anticipated at the Challenge's inception that the future flight sector would make a relatively modest contribution to the overall aviation and aerospace sectors within the first decade following the FFC's creation.

It is important to recognise that economic activity generated by the FFC may not represent net additional growth for the UK economy, as it could involve reallocating (displacing) resources from other sectors to aviation and aerospace. Similarly, spillovers to adjacent sectors, such as knowledge transfers, may not be directly reflected in the contributions of aviation and aerospace but remain critical to the broader economic impact of the FFC.

3.12.3 Evaluation evidence

It is important to note that, while there is some evidence of the Challenge's contribution to the development of future flight clusters (see Section 3.9), it is still too early to assess its broader impact on the wider aviation and aerospace sector. However, our approach provides non-

causal, descriptive insights into the relationship between the FFC and sector performance metrics. Therefore, our findings should be viewed as descriptive rather than indicative of causal relationships, as they primarily serve to contextualise sector trends. Additionally, business performance data is only available up to approximately 2023, providing a maximum of four years of post-FFC information.

The assessment of the future flight contribution to the aviation and aerospace sectors in the UK economy uses firm-level data provided by the Business Structure Database (BSD). The main objective of this analysis is to identify trends in key metrics (such as the number of firms, turnover levels, and employee counts) in the future flight sector before and after the establishment of the FFC. Additionally, it enables us to assess whether the performance trends of organisations that applied for and received funding from the Challenge (successful and unsuccessful companies hereinafter) differed from those of other firms in the future flight sector.

Standard Industrial Classifications (SICs) lack the specificity needed to identify emerging and highly specialised sectors such as the future flight sector. To address this limitation, the list of applicant companies to the Challenge was linked to the BSD using their Company Registration Numbers (CRN). We then explored which 5-digit SIC associated with each company to develop market definitions that could be applied to other data sources. We developed a "narrow" definition, focused on traditional aviation and aerospace activities, and a "wider" definition which also includes common 5-digit SIC codes among FFC applicants. The SIC codes considered in each market definition are outlined in Table 22 and Table 23.

Table 22 Narrow market definition - List of SIC codes

Code	Description
26511	Manufacture of electronic instruments and appliances for measuring, testing and navigation, except industrial process control equipment
30300	Manufacture of air and spacecraft and related machinery
33160	Repair and maintenance of aircraft and spacecraft
51101	Scheduled passenger air transport
51102	Non-scheduled passager air transport
51210	Freight air transport
52102	Operation of warehousing and storage facilities for air transport activities
52230	Service activities incidental to air transportation
52242	Cargo handling for air transport activities
77351	Renting and leasing of passenger air transport equipment

Code	Description
77352	Renting and leasing of freight air transport equipment

Source: *Frontier Economics using FFC monitoring data and ONS/BSD*
Note: *List of SIC codes traditionally associated with traditional aviation and aerospace activities.*

Table 23 Wider market definition – List of SIC codes

Code	Description
71129	Other engineering activities
71121	Engineering design activities for industrial process and production
71122	Engineering related scientific and technical consulting activities
72190	Other research and experimental development on natural sciences and engineering
74909	Other professional, scientific and technical activities
42990	Construction of other civil engineering projects
27110	Manufacture of electric motors, generators and transformers
62012	Business and domestic software development
62020	Computer consultancy activities
62090	Other information technology and computer service activities
61900	Other telecommunication activities
70229	Management consultancy activities other than financial management
74901	Environmental consulting activities
82990	Other business support service activities
96090	Other personal service activities

Source: *Frontier Economics using FFC monitoring data and ONS/BSD*
Note: *Additional SIC codes to those presented in Table 22. List of SIC codes that represent at least 70% of FFC successful applicants.*

The SIC codes which represent the wider definition, along with the traditional aviation and aerospace codes, captured at least 70% of applicants to FFC competitions. It is important to note that the wider definition includes activities associated with traditional aviation and aerospace industries as well as other sectors that produce non-future flight technologies (i.e., related to manufacture, engineering, research, technology, business support, and consultancy). Additionally, some future flight technologies are developed in sectors not captured by these codes, making this a low-fidelity proxy for accurately representing the future flight sector.

As discussed in Section 3.9, employment and turnover figures were adjusted using evidence from the industry survey[73] to more accurately reflect the share of business activities dedicated to future flight technologies. Specifically, it was assumed that 8% of employment and turnover in micro firms, 6% in small firms, 5% in medium firms, and 1% in large firms are attributed to future flight activities.

Number of companies

In 2023, around 715,000 companies had SIC codes similar to the majority of FFC applicants ("wider definition"), with nearly 9,000 specifically engaged in traditional aviation and aerospace activities ("narrow definition"). Since 2019, this group of firms has experienced a gradual decline, down from 808,000 companies, including 9,600 in traditional aviation and aerospace, reflecting an average annual growth rate of -3%. This is notably lower than the UK's overall average net business birth rate of less than 1%.[74] The decline has primarily been driven by a reduction in micro and small firms, which comprised 99% of the group in 2023. Conversely, medium-sized firms have increased by 4% over the same period, indicating a shift toward consolidation and scaling within the sector.

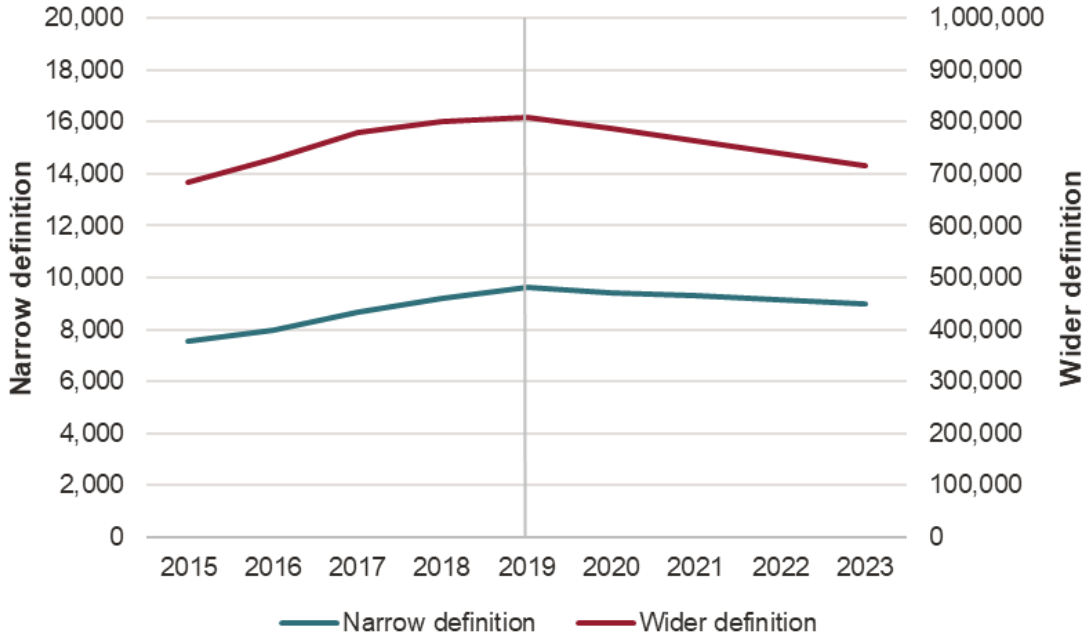
When analysing SIC codes, companies engaged in "Management consultancy activities other than financial management" accounted for 27% of the sector in 2023. Similarly, "Other business support service activities", representing 20% of the sector, has also experienced a significant drop. In the traditional aviation and aerospace activities, "Repair and maintenance of aircraft and spacecraft" has experienced the largest decline. Meanwhile, "Freight air transport", "Cargo handling for air transport activities", and "Service activities incidental to air transportation" have shown slight growth, although these areas represent only a small portion of the overall sector. [75]

[73] Industry Survey. A2A/A2B. Which of these bands would best describe the proportion of your organisation's business that is focussed on future flight technologies?.

[74] ONS (2023) Business demography in the UK

[75] Annex B provides detailed time series in the future flight sector by SIC code.

Figure 47 Number of companies by market definition



Source: *ONS/BSD*

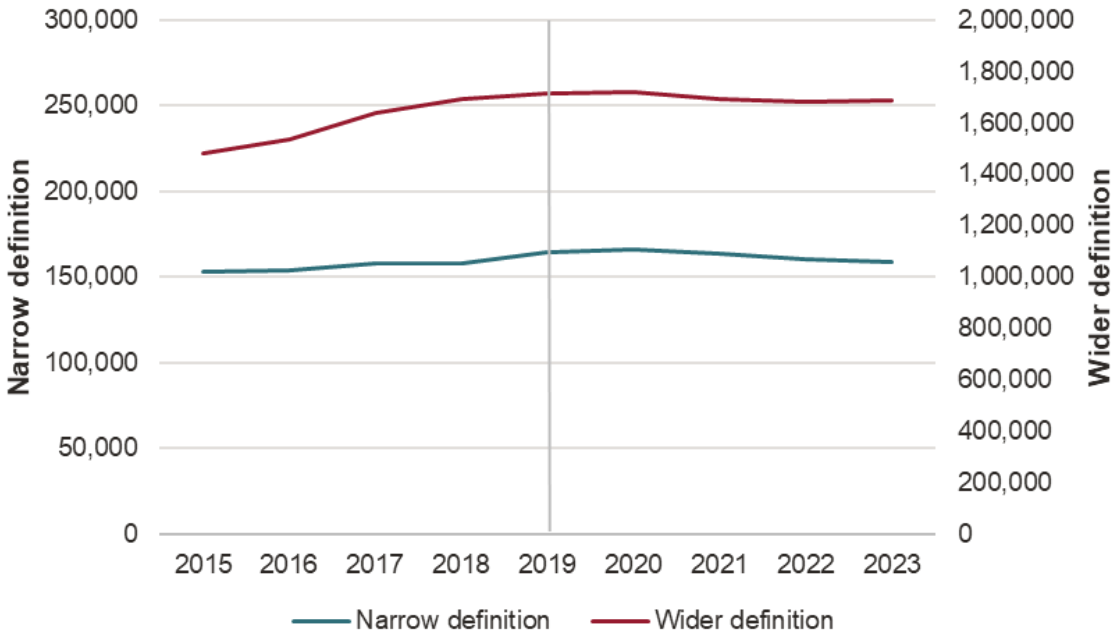
Note: *The narrow definition encompasses SIC codes traditionally linked to aviation and aerospace activities, while the wider definition includes SIC codes representing at least 70% of FFC applicants. The vertical line marks the year the FFC was established.*

Employment counts of firms similar to FFC applicants

In 2023, companies that operated within SIC codes similar to the majority of FFC applicants employed a total of 1.7 million people ("wider definition"), including approximately 160,000 in traditional aviation and aerospace activities ("narrow definition"). Employment levels have remained relatively stable since 2019, with a modest increase observed in medium-sized companies, reflecting the sector's gradual scaling and consolidation.

A significant share of employees in the future flight sector are concentrated in "Management consultancy activities other than financial management", highlighting its central role in the industry, while employment in "Operation of warehousing and storage facilities for air transport activities" and "Renting and leasing of passenger air transport equipment" remains comparatively low, suggesting limited workforce engagement in these areas. These patterns underscore the varied distribution of employment across the sector's diverse activities.

Figure 48 Total employment by market definition

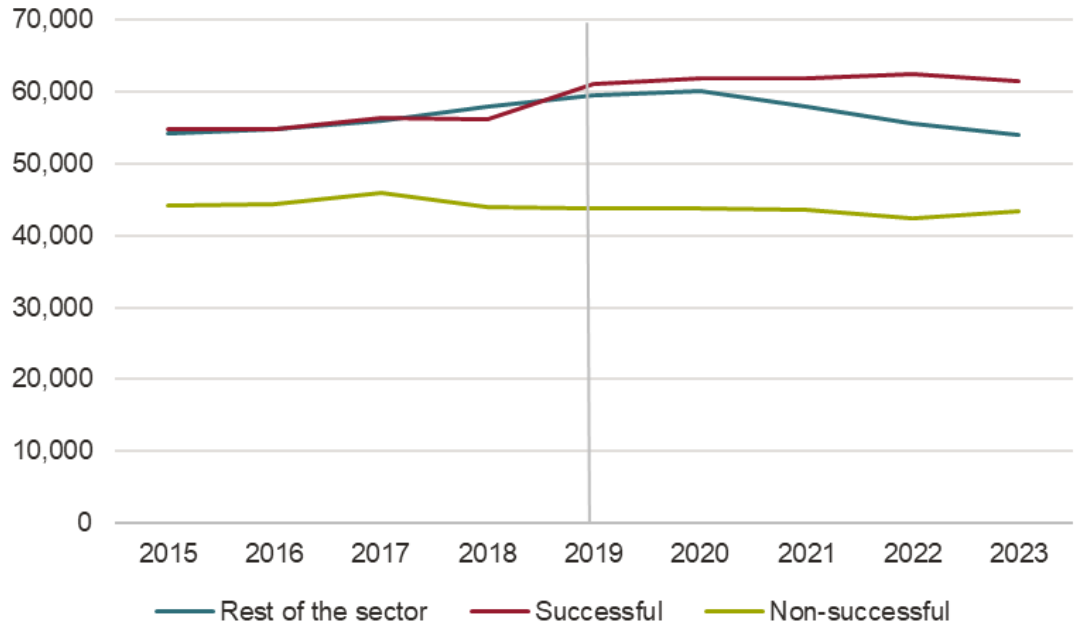


Source: *ONS/BSD*

Note: *The narrow definition encompasses SIC codes traditionally linked to aviation and aerospace activities, while the wider definition includes SIC codes representing at least 70% of FFC applicants. Total employment has been adjusted to account for the proportion of business activities dedicated specifically to future flight technologies. The vertical line marks the year the FFC was established.*

When comparing companies that had participated in the Challenge competitions with those in the traditional aviation and aerospace sector (as defined by the "narrow" definition), we found that employment counts remained relatively stable over the analysis period. However, since 2019 (the year the FFC was established) companies that had not applied to any of the competitions experienced a 2% decline in employment levels.

Figure 49 Total employment by type of engagement with the FFC ("narrow" definition)



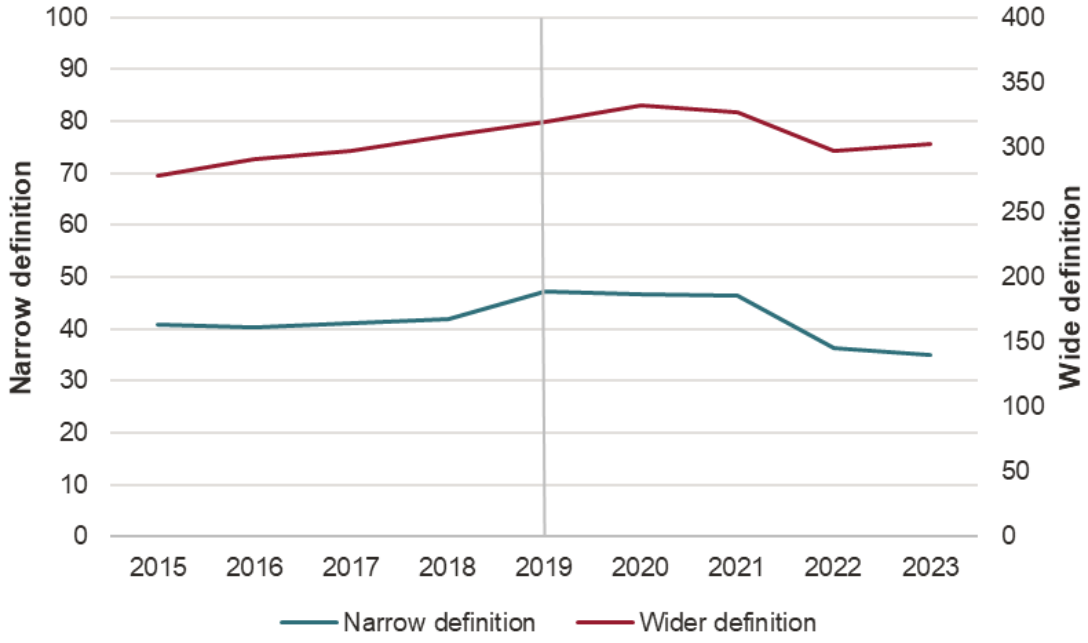
Source: *ONS/BSD, FFC monitoring data*

Note: *Total employment has been adjusted to account for the proportion of business activities dedicated specifically to future flight technologies. The vertical line marks the year the FFC was established.*

Turnover levels of firms similar to FFC applicants

In 2023, companies operating within SIC codes similar to the majority of FFC applicants generated £302 billion in turnover, with nearly £35 billion stemming from traditional aviation and aerospace activities. This marks a decline from £319 billion in 2019, largely due to a reduction in micro and small firms, which still made up 99% of the sector. Meanwhile, turnover from medium-sized firms rose by 2%, providing further evidence of ongoing industry consolidation and scaling, as highlighted in other sections. Two core areas – "Other business support service activities" and the "Management consultancy activities other than financial management" – accounted for nearly 38% of the sector's economic output, underscoring their significant contribution to the future flight ecosystem.

Figure 50 Total turnover by market definition (£ billions, real)



Source: *ONS/BSD*

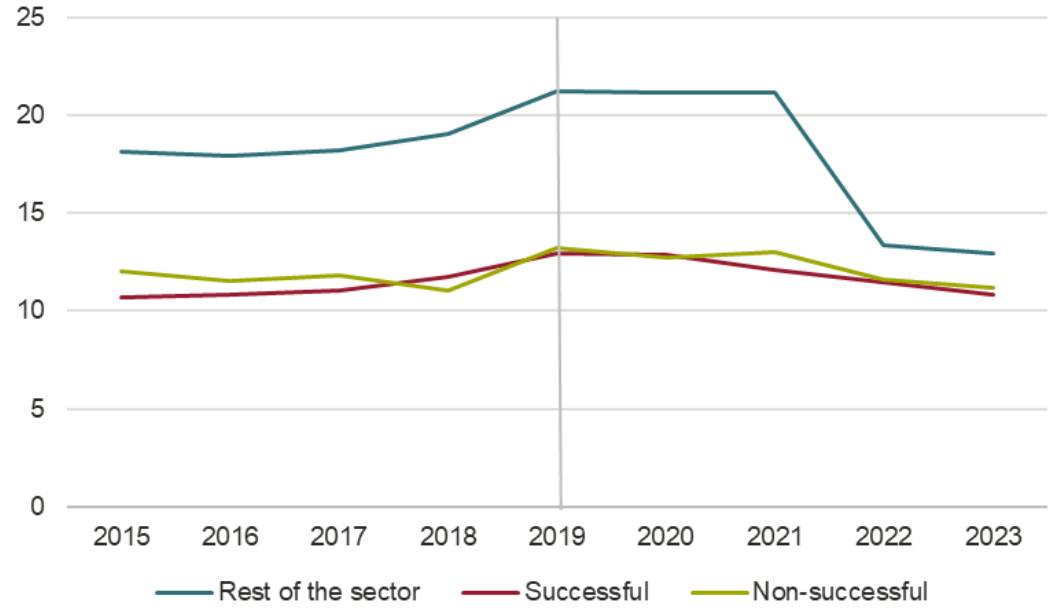
Note: *The narrow definition encompasses SIC codes traditionally linked to aviation and aerospace activities, while the wider definition includes SIC codes representing at least 70% of FFC applicants. Turnover has been adjusted to account for the proportion of business activities dedicated specifically to future flight technologies. The vertical line marks the year the FFC was established. Base year = 2019.*

In 2023, private sector businesses in the UK generated a total turnover of £6.33 trillion.[76] Based on this, companies in sectors similar to FFC applicants contribute approximately 4.8% of the UK economy, a share comparable to established industries such as information and communication (5.6%), construction (5.5%), and business administration and support services (4.8%). This underscores the significant economic role of the future flight sector, particularly given its broader scope beyond traditional aviation and aerospace. By comparison, the traditional aviation sector accounts for less than 1% of the UK's total turnover.

When comparing companies based on their level of engagement with the Challenge, we found that turnover had declined by 12% since 2019 for those in the traditional aviation and aerospace sector (as defined by the "narrow" definition) that had not applied to any of the competitions. While turnover had also decreased for FFC applicants (by -4%), the decline was less pronounced compared to the rest of the sector as observed in Figure 51.

76 ONS, Non-financial business economy, UK: Sections A to S

Figure 51 Total turnover by type of engagement with the FFC (£ billions, real)



Source: *ONS/BSD, FFC monitoring data*

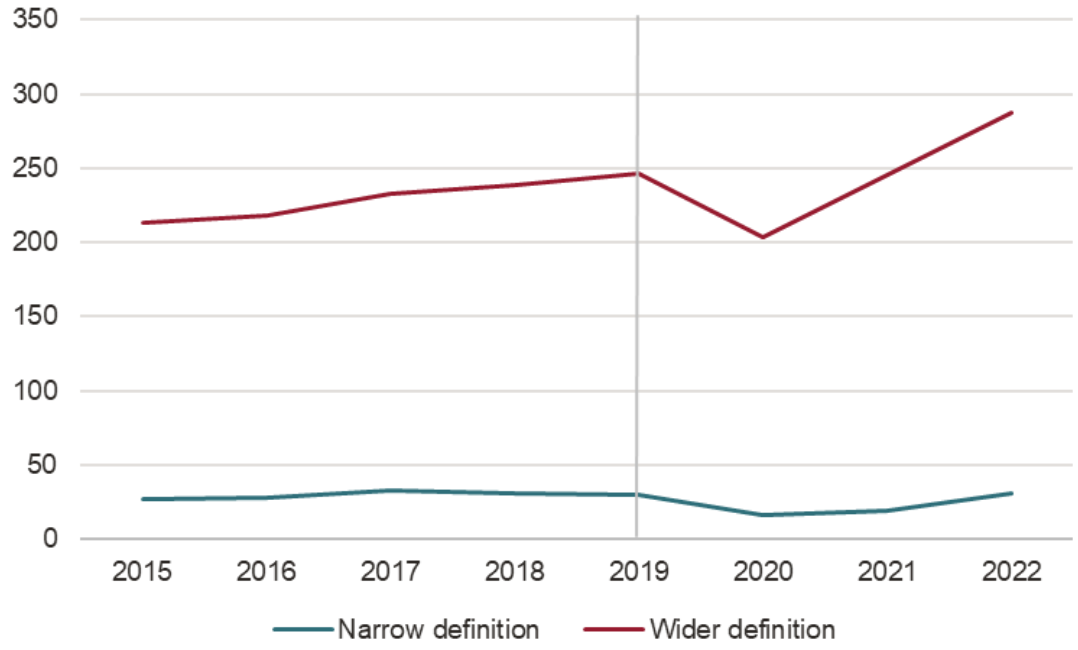
Note: *Turnover has been adjusted to account for the proportion of business activities dedicated specifically to future flight technologies. The vertical line marks the year the FFC was established. Only includes companies with complete information over the period under analysis. Base year = 2019.*

Gross value added (GVA) of firms similar to FFC applicants

The GVA of firms similar to FFC applicants is derived from the Annual Business Survey (ABS). However, since publicly available ABS data lacks the same level of granularity as the analysis conducted using BSD, the GVA figures presented in this section are not directly comparable to the employment and turnover levels discussed earlier.

In 2022, the GVA generated by companies operating in SIC codes similar to the majority of FFC applicants was approximately £288 billion, up from £246 billion in 2019, which represents an increase of 6% in the last five years. This growth has been driven mainly by non-aviation activities such as “Other business support service activities”, “Management consultancy activities other than financial management”, and “Computer programming activities”, which together represent almost half of the sector’s GVA in recent years. Around 11% of this GVA is created by traditional aviation and aerospace activities, with the most growing activities being “Manufacture of air and spacecraft and related machinery” and “Cargo handling for air transport activities”.

Figure 52 Gross value added (GVA) by market definition (£ billions, nominal)



Source: *ONS, https://www.ons.gov.uk/economy/grossvalueaddedgva*

Note: *The narrow definition encompasses SIC codes traditionally linked to aviation and aerospace activities, while the wider definition includes SIC codes representing at least 70% of successful FFC applicants. The vertical line marks the year the FFC was established. Base year = 2019.*

In 2022, the UK's GVA was £2.26 trillion.[77] Based on this, companies operating within SIC codes similar to those of FFC applicants contributed up to 13.4% of the UK's GVA, a share comparable to the production sector (14.3%). In contrast, the traditional aviation sector accounted for just 2% of the UK's GVA. This disparity highlights the value of adopting a broader definition of the future flight ecosystem which includes companies operating in areas like software development, technology services, consultancy, and advanced manufacturing. These supporting industries play a crucial role in driving innovation and growth within the sector, reinforcing its potential to shape the UK's economic landscape significantly.

77 ONS, Gross Value Added

4 Commercialisation and industrialisation

The organisations supported by the Challenge have progressed since their initial engagement and are now exploring the next steps in their journey toward in-service operations. Accordingly, the Challenge has sought to understand how its support has contributed to preparing the sector for the industrialisation and commercialisation of future flight technologies through all its contributions outlined in Section 3. This topic was the focus of one of the case studies and extends beyond the evaluation themes outlined in the Challenge's theory of change.[78]

Both industrialisation and commercialisation become crucial as technologies advance to the highest readiness and certification levels, transitioning from research and innovation to in-service operations. **Industrialisation** refers to the process of integrating future flight technologies into the industrial sector, which includes aspects such airspace integration systems (e.g., electronic conspicuity and detect-and-avoid technologies), industrial airworthiness, safety, environmental and cybersecurity standards, supporting infrastructure (e.g., vertiports and charging stations), operational readiness (e.g., competencies and skills), and R&D for overcoming technological limitations like alternative fuels and batteries. **Commercialisation**, on the other hand, is understood as the process of bringing future flight technologies to market to achieve economic returns on investment. This process requires addressing public concerns about safety, privacy, overflight, and noise while ensuring physical, geographical, and financial accessibility.

Although the Challenge did not explicitly set the industrialisation and commercialisation of future flight technologies as one of its objectives, evidence from the Development and Demonstration Phases suggests that this was the natural next step for certain technologies that had already achieved higher TRLs, particularly UAS. Continued private investment in these technologies is heavily reliant on their successful industrialisation and commercialisation, as investors require a clear pathway to in-service operations.

Evidence from the case studies shows that the Challenge has supported the advancement of the future flight sector by enabling demonstrations and identifying pathways for the deployment of technologies, particularly for UAS and eVTOL. These demonstrations have enabled stakeholders to test the feasibility of these technologies, identified use cases, and gained critical insights into the operational, regulatory, and technological barriers that need to be addressed to advance industrialisation and commercialisation.

Stakeholder interviews highlighted that prior to the Challenge's launch in 2019, the industry's primary focus was on R&D and exploring potential use cases, and little attention was given to industrialisation or commercialisation of future flight technologies. Regulatory barriers, particularly for BVLOS operations, posed significant challenges, limiting the ability to test and demonstrate the potential benefits of future flight technologies. Additionally, policy

[78] The topic of this case study was agreed as part of the review of the evaluation framework in January 2024.

development at the time was still in its early stages, offering limited guidance to support the sector's growth. Stakeholders agreed that these conditions had led to cautious investment and a slower pace in exploring how future flight services could effectively integrate into shared airspace alongside crewed aviation.

Since the Challenge's intervention, case studies have revealed that several key barriers, especially those related to technology development, have been identified and mitigated, with remaining risks increasingly accompanied by action plans (i.e., CAA's Airspace Modernisation Strategy, DfT's Future Flight Action Plan).[79] The growing demand for UAS in logistics, emergency services, and infrastructure inspection has spurred private investment and increased interest in commercial applications. Public perception has also improved, with Challenge demonstrations showcasing societal benefits and addressing safety, privacy, and environmental concerns. Stakeholders interviewed noted that this momentum had placed additional pressure on the government and regulators to accelerate the development of a regulatory framework to enable initial in-service operations (see Section 3.4).

According to stakeholders interviewed, one of the major contributions of the Challenge has been fostering collaboration between regulators, SMEs, large organisations, and other stakeholders. This collaboration has provided a clearer understanding of the future flight ecosystem and the required steps to achieve operational readiness. The Challenge has also accelerated regulatory engagement, ensuring that the frameworks for enabling commercial operations evolve in line with technological advancements. By doing so, the FFC has also supported the establishment of industry standards (e.g., UK SORA) and facilitated progress in key areas such as airspace integration, detect-and-avoid systems, and safety assurance.

Despite the observed changes in the future flight landscape, stakeholders expressed mixed views on the sector's progress toward commercialisation and the Challenge's role. Some organisations expected the sector to be ready for commercial operations by the end of the Demonstration Phase, even though this was not its primary objective. Several stakeholders believed that the complexity of integrating future flight technologies into a shared airspace was underestimated, with efforts required beyond the Challenge's original scope.

> *"There are ready-to-go products with no market on which to capitalise." – Industry stakeholder*

Industry stakeholders interviewed highlighted that projects during the Demonstration Phase placed insufficient focus on developing commercial models, which created challenges for some organisations. In particular, a common concern among SMEs interviewed was the absence of a clear directive to transition from demonstration to in-service operations.

The lack of commercial readiness and uncertainty due to unclear general timelines, costs, and return on investment has adversely impacted the willingness of the private sector to invest. In

[79] CAA (2024) Airspace Modernisation Strategy and DfT (2024) UK Future Flight Action Plan

fact, some organisations expressed a preference to wait for other countries to "take the lead", enabling them to learn from their experiences and minimise their own costs.

> *"The UK is known for promoting innovation but struggles historically to commercialise." – Industry stakeholder*

Lessons learnt shared by stakeholders interviewed highlighted several critical areas that require attention to advance the industrialisation and commercialisation of future flight technologies. While the Demonstration Phase included some system-level testing, stakeholders emphasised that more extensive integrated demonstrations were necessary to validate the interactions between different systems and provide the operational evidence required for regulatory progress. This testing is vital to ensure the safe integration and adoption of future flight technologies.

The slow pace of regulatory development, particularly for BVLOS operations, remains a significant barrier. Smaller organisations, including SMEs, face difficulties in developing or sourcing certified systems due to high costs and complex requirements. The limited adoption of enabling technologies, such as electronic conspicuity devices, further complicates the integration of drones and other future flight technologies into the UK's already crowded airspace. Establishing agreed standards that underpin both the design and operation of future flight vehicles is critical to enabling sector progress.

Infrastructure readiness is another major challenge. Stakeholders identified a lack of essential infrastructure, such as vertiports, charging stations, and robust electricity networks, which restricts the scalability of eVTOL and other future flight operations. The UK's complex airspace, shared by commercial aviation, general aviation, and military operations, adds additional layers of difficulty in integrating new technologies. Stakeholders underscored the need for substantial investment in both physical and digital infrastructure to facilitate seamless operations and support the sector's growth.

Additionally, the maturity of the UK's supply chain presents another significant challenge. Stakeholders observed that the current supply chain is insufficient to support the scaling of operations outlined in industry plans. A reliable and well-funded supply chain, capable of addressing essential elements such as materials, power, manufacturing, and transportation, is crucial for achieving industrialisation and meeting the anticipated demand for future flight services.

Despite the challenges, stakeholders acknowledged that the FFC has significantly advanced the sector by identifying and addressing key barriers to in-service operations, bringing the industry closer to enabling the third aviation revolution. While much work remains, the Challenge has provided a strong foundation for future growth and development.

Looking ahead, stakeholders emphasised the need for future programmes to prioritise commercialisation and industrialisation efforts. These efforts should focus on integrating technology, regulation, and infrastructure, supported by demonstrations that address economic modelling, resilience, and assurance. Incorporating real-world operational models

into future projects could bridge the gap between R&D and in-service operations, offering a clearer understanding of customer-supplier dynamics and facilitating the transition to commercial services.

The development of technical standards for design, manufacturing, and operations was also identified as a critical step toward commercial readiness. Consolidated standards would streamline regulatory approvals, support production scale-up, and enhance operational efficiency. To move forward efficiently, investment in the development of these standards, coupled with close collaboration between the BSI and CAA and ongoing industry consultation, is essential.

Stakeholders further highlighted the importance of an agreed industry roadmap to guide the transition from demonstrations to in-service provision. Such a roadmap should outline key activities, milestones, approval gates, and timelines, offering clarity for all stakeholders. This framework would not only unlock private investment but also help SMEs and larger organisations to align their efforts to achieve common goals.

Lastly, stakeholders suggested that future public funding should adopt a more targeted approach, focusing on specific technologies or use cases, such as UAS operations. This focused strategy could accelerate progress, reduce regulatory uncertainty, and create a foundation for broader adoption of advanced technologies like eVTOL. By building on the successes of the Challenge and addressing these priorities, the UK's future flight sector can advance toward achieving its commercial and industrial goals.

5 Conclusions, lessons learnt, and recommendations

The survey and case study evidence indicate that the FFC has been instrumental in driving advancements in the UK's future flight sector by enabling technological progress, fostering collaboration, and mobilising private and public investment. However, ongoing challenges need to be addressed to sustain progress, strengthen the UK's international position, and gain competitive advantages in the global future flight market.

By **enhancing the technological readiness** within projects, particularly those already at high or medium TRLs such as UAS and eVTOLs, the Challenge has accelerated the development of innovative technologies closer to commercial viability. Demonstrations have highlighted the potential for low-emission solutions and operational efficiencies, while also clarifying the costs, risks, and barriers that need to be addressed. This focus on technological readiness has been pivotal in laying a strong foundation for the sector's growth.

Stakeholders interviewed as part of the case studies recognised that the most significant achievement of the FFC has been its success in **fostering collaboration** across diverse organisations. The Challenge has facilitated partnerships among SMEs, large firms, regulators, government bodies, local authorities, and international players, creating a unified future flight community. This environment has encouraged knowledge sharing, increased partnerships, and accelerated the pace of innovation, supported by domestic and international events such as DroneX and the Farnborough International Airshow FIA.

Since the Development (2021-2022) and Demonstration Phases (2022-2025), both **private and public investment in the sector have seen a notable boost**, with the Challenge exceeding its co-investment target and publicly funded research expanding substantially, as highlighted by information from the Gateway to Research portal. In the survey, winning consortia widely self-reported **increased private R&D spending**, much of which represents new funding, demonstrating the Challenge's role in catalysing financial commitment to the sector.

However, SMEs face significant hurdles in securing long-term investment, which has been further exacerbated by the UK's competitive disadvantages compared to markets such as the US and EU, which benefit from larger funding pools, more streamlined testing processes (e.g., waiver approach) and more advanced infrastructure (e.g., greater uptake of electronic conspicuity devices). Additionally, some jurisdictions have a natural advantage due to the availability of vast unoccupied spaces for testing (e.g., Canada and Australia) or limited general aviation activity (e.g., China). These issues raise **concerns about the sustainability of funding mechanisms** after the Challenge concludes, leaving SMEs particularly vulnerable.

Industry stakeholders acknowledged the progress made in developing new regulatory frameworks and standards since the interim evaluation but the sector's **regulatory landscape remains a critical bottleneck**. Stakeholders noted that slow approval processes and restrictive requirements hinder progress toward commercial operations.

Although the Challenge did not explicitly define the industrialisation and commercialisation of future flight technologies as one of its objectives, in the future, commercial readiness is a significant challenge for industry stakeholders. While the FFC has successfully showcased the potential of future flight technologies through various demonstrations, the **transition to in-service operations has progressed more slowly than expected,** as noted by industry stakeholders interviewed. In particular, they highlighted the lack of clear pathways and timelines for commercial deployment as a barrier to private sector confidence and investment. Furthermore, the integration of emerging technologies into shared airspace, coupled with the lack of well-established business models, limits scalability and broader adoption.

Infrastructure readiness presents an added challenge, as the **lack of supporting physical and digital infrastructure** restricts the scalability of eVTOLs and BVLOS operations. Essential components like vertiports, charging stations, and robust electricity networks are either underdeveloped or non-existent, creating barriers to widespread adoption. The complexity of integrating these technologies into the UK's already congested airspace may further exacerbate these issues.

Looking ahead, addressing these systemic challenges is crucial for unlocking the full potential of the UK's wider future flight sector. Based on insights from the case studies, the following list of lessons learnt has been identified:

- **More frequent, integrated, real-world demonstrations:** Large organisations valued the demonstrations conducted during the Challenge but noted that increasing their scale and frequency would provide more robust data to drive regulatory advancement and better represent integrated real-world airspace operations. Demonstrations should involve multiple future flight technologies operating within a shared airspace alongside manned aviation, supported by detect-and-avoid systems, airspace management solutions, and coordinated flight procedures to ensure safe and efficient operations.
- **More focused investment could yield greater impact:** SMEs noted that, while the Challenge supported a wide range of use cases and technologies, concentrating resources on fewer, high-impact areas might have produced more meaningful progress toward operational and commercial readiness.
- **Enhance regulatory clarity and development:** Industry stakeholders highlighted the need for a regulatory framework that keeps pace with technological innovation and facilitates the integration of future flight technologies into the UK's airspace. However, it is essential for all stakeholders to recognise that achieving a mature regulatory environment will take time and resources and require close coordination between all players involved.
- **Need to increase uptake of electronic conspicuity:** Stakeholders agreed that the UK's slower pace in mandating electronic conspicuity devices presents additional challenges for seamless integration in a shared airspace environment.
- **Need for greater data sharing and transparency:** While Challenge demonstrations provided valuable insights into future flight operations, some large organisations noted that limited data sharing by the CAA and across the sector hindered broader progress.

Improving transparency and disseminating findings more broadly could help minimise duplication of efforts and support organisations in refining their operations.

- **Scaling-up requires greater resources:** The transition from demonstrations to in-service operations was identified as particularly challenging due to the significant increase in funding and resources required, which often exceeded the capacity of SMEs.
- **More emphasis on commercial readiness:** Some SMEs perceived that the Challenge should have focused more on creating clear pathways for commercialisation, as there is a need for guidance and strategic direction in developing business models to scale up operations.
- **Managing public expectations:** Large organisations cautioned against overpromising futuristic concepts like "flying taxis" without demonstrating tangible progress. They emphasised that aligning communication with near-term, achievable goals would help build trust and credibility with the public.
- **Enhancing global competitiveness:** Stakeholders noted that, while the UK has made significant progress, its funding levels and regulatory environment lag behind international competitors, making it less attractive for global investment and operations. Addressing these disparities is essential for strengthening the UK's position in the global market.

Building on these lessons, stakeholders and experts proposed a series of actionable recommendations:

- **Preserve expertise and collaboration networks:** Industry stakeholders emphasised the importance of retaining and building on the expertise, partnerships, and networks established during the Challenge. This could be achieved through ongoing coordination, support, and funding of events that bring the community together to discuss opportunities, strategies, and industry advancements. Maintaining these connections would help sustain momentum, foster innovation, and support the continued development of a well-integrated future flight ecosystem.
- **Clear vision and strategy for the future flight sector:** Both large organisations and SMEs called for a clear, unified vision and strategic plan from the UK government to guide the sector. This includes increasing public sector investment to demonstrate government commitment, attract private funding, and showcase successful commercial use cases, which would help build investor confidence.
- **Development of clear roadmaps for commercialisation:** SMEs called for government-led roadmaps to provide structured guidance for transitioning from demonstrations to in-service operations. These roadmaps should include detailed steps for manufacturing, scale-up, market integration, and regulatory compliance, helping smaller organisations to navigate the path to commercial readiness.
- **Ensure continued financial support:** SMEs stressed the need for ongoing funding opportunities to bridge the significant financial gap between demonstration and commercial operations. Without sustained financial support, smaller organisations risk being unable to stay and compete in the market.

- **Enhance regulatory flexibility:** Regulators and industry stakeholders jointly identified the need for a more flexible regulatory framework. They suggested moving away from operational restrictions and toward an approach that emphasises equipment certification, such as electronic conspicuity. Some stakeholders recommended interim measures, like dedicated air corridors for BVLOS UAS and eVTOL operations, to facilitate early-stage operations while long-term frameworks are consulted and finalised.
- **Collaboration on technical standards:** Industry stakeholders emphasised the need for collaboration between organisations like the CAA and BSI to establish robust technical standards. These standards should address the design, manufacturing, and operation of future flight technologies and ensure alignment with international counterparts like EASA and the FAA, simplifying regulatory approvals and fostering international consistency.
- **Investment in critical infrastructure:** Industry stakeholders highlighted the urgent need to develop enabling infrastructure such as vertiports, charging stations, and advanced airspace management systems. They also suggested leveraging general aviation airports as cost-effective hubs for early-stage operations to support the deployment of eVTOL and UAS technologies.