The Changing Nature of R&D

Building an innovation ecosystem for the data age

In partnership with

NEXUS
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Innovation

NEXUS
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About the partner

Nexus enables businesses to connect with the expertise, talent and facilities at the University of Leeds. A dedicated team are responsible for facilitating productive working partnerships and collaborations, to accelerate and de-risk innovation and maximise commercial returns.

Successful innovation is nothing new to the University. Leeds has a proven track record of commercialisation, creating over 110 companies in the last 20 years, 6 of which are AIM market listed with a combined value in excess of £500m.

At the heart of Nexus is a community of technology businesses of all shapes and sizes. It provides access to specialist service providers, investors, mentors, business advisors, graduate talent and networking opportunities with other entrepreneurs, SMEs and corporates. Nexus is a place where conversations start, ideas form and solutions emerge.

For further information, contact:

T: 0113 306 1444
E: hello@nexusleeds.co.uk
W: nexusleeds.co.uk

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Foreword CBI

Data, data everywhere. And growing at an unprecedented pace. From health to mobility to climate change. The capacity to derive insight and value from such data is no longer limited to the few. Advances in technologies and tools to collect, store and analyse these data are becoming widely accessible. Businesses are increasingly using data as a key raw material in their R&D.

The potential is vast. Data analytics will contribute over £46 billion a year to the UK economy by 2020,[1] some 2% of GDP. Embracing data-driven R&D could unlock enormous potential value. But work is required for the UK to reap the benefits.

We start in a good place. The UK's research base is the most productive across the G7. We are home to world-leading universities and a thriving start-up community, with over a third of Europe's tech unicorns located in the UK. Our innovations in life sciences, automotive and the creative industries are famous around the world.

Individuals, communities and businesses across the UK stand to gain. But historic strengths don't guarantee future success. And the competition is fierce, with other countries striving to hit the front.

The Industrial Strategy sets out ambitions to put the UK at the forefront of the data revolution and to raise the R&D intensity of the UK. This ambition needs to be matched by action that responds to how innovation is being disrupted by data and analytics.

In this report, the CBI sheds light on how innovation is changing and the new set of challenges that businesses across sectors are facing. Firms are redesigning their business models, creating new roles, investing in digital infrastructure and taking new risks. The policy, funding and regulatory environment must now rapidly evolve to keep pace. We identify practical recommendations for action that will help grow the number of businesses harnessing the value of their data and make it easier to navigate the innovation system.

By embracing these findings, the UK can be at the forefront of harnessing the latest trends in innovation and remain a great place to do business.

Matthew Fell
Chief UK Policy Director, CBI

The potential on offer is vast. By 2020 alone data analytics will contribute over £46 billion per year to the UK economy.

Foreword Nexus - University of Leeds

The current opportunities for harnessing the power of data are extraordinary. It is transforming how businesses advance their research and development, and powering our ambitions to ensure Britain remains a global leader in technology and innovation.

The report highlights the impact that collaborative innovation can have on the UK's future success and prosperity, and the new growth opportunities and competitive advantages that can be gained for businesses by embedding innovation in their core strategy.

Alongside this, some challenging themes have emerged from this report and it is clear that greater support is needed to help businesses maximise the potential of this technological revolution.

In the foreword of the Industrial Strategy, the Prime Minister stated that "we are not fulfilling Britain's potential if, despite having scientists and universities renowned the world over, we cannot turn their ideas into products and services on which the industries of the future will be built."

It is clear that Universities have a vital role to play in driving innovation and productivity. We have truly outstanding researchers, we are home to thriving start-up ecosystems, and we attract and develop the brightest talent and best minds in the world.

The report has highlighted that we must do more to enable stronger links between business and academia, to create the right partnerships that turn exciting data-driven ideas into products, services and practices, and support the foundations of productivity.

This is why the University of Leeds has chosen to partner with the CBI on this report, to offer insight into how businesses are using data to innovate.

The report identifies a clear shift in R&D spend towards software and services, highlighting a critical demand by businesses to make better use of their data and exploit opportunities to access new data. It also identifies the need to invest in and upskill the workforce in order to increase their data analytic capabilities to better understand and exploit the value of this data and build competitive advantage.

At Leeds, we are making a step change in how we work with businesses to support this demand. Work within our Leeds Institute of Data Analytics and our partnership with the Alan Turing Institute is tackling a wide range of societal, health and environmental problems, as well as inspiring the next generation of leaders through our skills development programmes. We are also seeing a shift towards more collaborative innovation with business, which aligns perfectly with the University's new approach to business engagement. One clear signal of our commitment to this is the investment in our new innovation hub, Nexus. It builds on our outstanding track record of commercialisation and will enable businesses to have seamless access to the expertise, talent and facilities at the University.

We're proud to have partnership working front and centre of our research and innovation strategy; we are working with businesses to create knowledge and opportunity, exchange ideas, support new areas of growth and, ultimately, to help make a difference to the regions in which we live and work. We can unlock the extraordinary potential of data-driven innovation and there has never been a better time for Universities and business to collaborate.

Professor Lisa Roberts
Deputy Vice Chancellor:
Research and Innovation, University of Leeds

Executive Summary

Chapter 1 Advances in data and analytics are changing research and innovation

The digital transformation of the world economy is having a major impact on how firms are approaching innovation. The global explosion in data production and advances in the power of analytics tools means business innovation is becoming increasingly data-driven. Data analytics is fuelling discovery and innovation, accelerating the R&D process, enhancing human decision-making and enabling new business models. Advances in data-driven technologies are also driving more open models of innovation. The complexity of data-driven technologies often goes beyond the capabilities that businesses hold internally, compelling businesses to pursue collaborative innovation strategies.

Chapter 2 The changing nature of R&D presents businesses with new challenges

Amid shifting innovation trends, we are at a critical inflection point. Some 'Data Native' businesses are leading the way on data-driven R&D. Other 'Data Novices' see the potential but are grappling with how to make the first step. Across this spectrum the changing nature of R&D presents businesses with a new set of challenges:

- There is a diverse range of understanding within businesses of the value of the data they hold, with many unsure of the value or how to exploit it
- There is a shortage of people with the specialist skills and competencies to ask the right questions and spot the opportunities
- Collaboration is increasingly important to maximise the value of data, but many firms don't know how to strike up the right partnerships
- Introducing new business models, strategies and investments pose new risks for businesses to manage

Chapter 3 The UK must take action to harness the potential of new innovation trends

The UK needs to better position itself to take advantage of new innovation trends and remain a destination of choice for innovative businesses. Government has set out the right intentions by committing to raise UK investment in R&D to 2.4% of GDP by 2027 and 3% in the long term. Urgent action is needed. Government must set out a comprehensive and future focussed roadmap, underpinned by commitments to raise public funding.

Building the UK's strengths and capabilities around data and analytics must be a key feature of this strategy. Government, business and universities must take action to foster uptake and usage of data and analytics amongst the UK's data novices and ensure the UK remains a destination of choice for the world's data natives.

Without action, the UK risks falling behind in an accelerating global innovation race. But with bold, ambitious, forward-looking policy action, the UK can capture the benefits of data-driven approaches to innovation, position itself as a global innovation frontrunner and take advantage of new growth opportunities.

Summary of Recommendations

1. Set out a comprehensive and future focussed roadmap underpinned by commitments to raise public funding

- Agree a long-term trajectory for government R&D expenditure
- Grow funding towards the development phase of R&D to support business innovation

2. Include measures to increase the number of businesses harnessing the potential of data and analytics in the government's roadmap to 3%

- Develop and deliver a 'competency building' package to support businesses to understand and unlock value from their data

3. Make it easier for businesses to navigate innovation support and strike up productive partnerships

- Establish a new 'business advisory group' for UKRI
- Implement a business development and outreach role in Innovate UK
- Increase visibility and simplicity of government and university innovation support

4. Position the UK as a global leader in data-driven R&D by setting out ambitious and creative policy

- Deliver the world's most competitive R&D tax credit by ensuring that it recognises the growing importance of data-driven R&D
- Embrace experimental policy approaches

5. Grow the UK's capability and capacity in high-level data and analytics skills

- Ensure the Government's retraining scheme has digital skills embedded, including targeted support for software engineering and data analysis skills
- Communicate skills needs across government
- Use management Knowledge Transfer Parnerships to increase management capabilities in data

Advances in data and analytics are changing research and innovation

Business innovation is becoming increasingly data-driven

The digital transformation of the world economy is having a major impact on how firms are approaching innovation. Amid a global explosion in data production and advances in the power of analytics tools, data and analytics are becoming a major input for business innovation.

In R&D, data analytics is speeding up the product development process. In materials science and drug development powerful data analytics can simulate and predict the results of experiments, reducing the testing burden and accelerating drug development and the discovery of new materials. Research in the electricity sector is using data forecasting to investigate the impact of low carbon vehicles on electricity networks and to understand what the energy flows of the future will look like.

In asset heavy sectors, businesses are using 'digital twins' – a virtual representation of a physical object – as a way to simulate test conditions, predict the performance of prototypes or identify where improvements can be made to physical assets. This reduces the number of physical experiments needed in product development, accelerating the R&D process.

Companies are also using data analytics to derive new sources of insight which form the basis of innovative new strategies, products and services. Analytics is being used in the manufacturing sector in predictive maintenance tools that monitor the condition of machinery and schedule maintenance in time to prevent breakdowns. That data and insight can then feedback into the development of improved products or parts. In banking, data analytics is being used in tools to help identify fraudulent transactions. In the media and creative industries, data analytics is being used to deliver hyper-personalized content and inform future products and services. And across industries, data analytics is helping businesses uncover and diagnose production and supply chain inefficiencies, enabling them to take action to optimise performance.

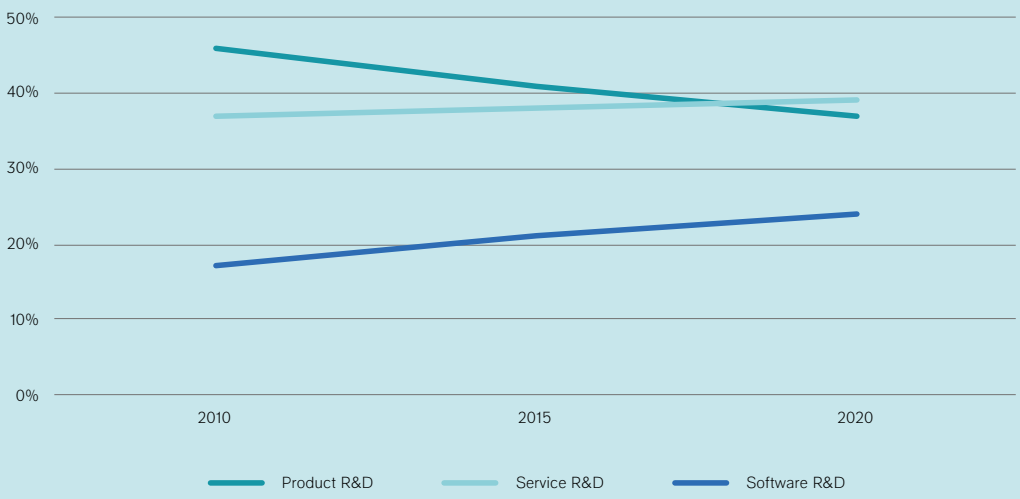
With advanced tools and technology now available, data can be used on such a scale that it enables whole new business models. Some of the world's most innovative and successful start-ups and companies such as Uber and Netflix have built their business models around data analytics. Altogether, the rise of data and analytics is fuelling a new innovation paradigm.

Global R&D Trends

The growing importance of data and analytics in R&D is borne out in global trends in investment and skills.

Investment Worldwide R&D growth is being driven by ICT services, with software and AI being key technological drivers of corporate R&D investments.[2] The world's 1000 largest R&D companies report shifting R&D spending away from products towards software and services. For example, between 2010-2015 R&D spending on products as share of global spend fell from 46% to 41% and is expected to fall to 37% by 2020.[3] R&D spending on software and services meanwhile grew from 54% to 59% over the same period and is expected to increase to 63% of global spend by 2020.[4]

Allocation of Business R&D Investment (%)



Source: Strategy&

Skills To support this transition, businesses' skills needs are also changing. In 2010 only 8 per cent of the world's 1000 biggest R&D spenders said that data engineers represented their largest group of engineers, by 2020 that figure is expected to double to 16 per cent.[5]

Data-driven technologies are driving more open models of innovation

The complexity of data-driven technologies often goes beyond the capabilities that businesses hold internally, compelling businesses to pursue collaborative innovation strategies. Businesses that traditionally held extensive internal R&D operations are increasingly pursuing 'open innovation' strategies. They are recognising the limitations of internal competences and engaging with external sources to bring new ideas, talent and knowledge in to the creative process. This approach avoids duplication of effort, facilitates problem solving and spurs innovation. By embracing external skills and perspectives, businesses significantly extend their innovative potential.

Interactions between industry and universities continue to rise,[6] with some businesses developing a network of long-term strategic research partnerships. Corporate venture capital investment is on the increase, with global funding up by 47% in 2018 and the number of deals up by 32%.[7] Corporate-start up collaborations are increasingly an essential part of companies' innovation strategies.[8,9] We are also seeing the emergence of new co-creation models where platforms like accelerators and collaboration spaces are reshaping the way that small businesses and start-ups approach innovation. Firms are also working with freelancers and using new methods like 'innovation tournaments' and crowdsourcing as new ways for firms to address innovation challenges.[10]

Case Study: Northumbrian Water Group

Smart Sewers

Northumbrian Water is the first water company in the world to install a fibre-optic 'nervous system' in a live sewer network. Rather than waiting for incidents to occur, this new development will enable Northumbrian Water to proactively resolve issues, improving their service to customers and reducing pollution.

The in-pipe technology will enable Northumbrian Water to measure water depth, flow and temperature in real time, every five metres along a sewer pipe. This generates vast volumes of real-time data. The data is then transferred into useful information to allow proactive and predictive management of the sewer system. This will help provide significant operational, financial and environmental benefits, including network resilience and improving overall customer satisfaction.

This innovative technology has been developed by nuron, a technology company set up to provide enhanced visibility of critical assets to sewer operators. It also provides the infrastructure to support the digital revolution.

The companies have been working together since 2015 and share a vision for transforming the way the wastewater infrastructure has been traditionally managed. The first of a kind installation project was launched at Northumbrian Water's Innovation Festival in 2018.

Digital Twinning

Northumbrian Water is partnering with Newcastle University to develop a world first, data-fuelled tool. The goal is to help protect communities from flooding and other major incidents, through the use of pioneering innovative software. It could change the whole industry in terms of how water companies plan and prepare for incidents, and future-proof their assets and networks.

The idea for the research came out of Northumbrian Water's Innovation Festival in 2018. Known as a 'digital twin,' the water company aims to create a virtual computer replica of Newcastle, based on data from across the city.

Four post-graduate students from Newcastle University are now working with the water company over the next three years to help develop the 'Twincident' idea. It will allow the water company, together with emergency responders to run simulations for locations during an incident – or before an incident might happen – and identify problems quicker and easier than ever before. It will help predict how cities and people will react to events such as major flooding.

Using digital twin technology in this way is a very ambitious project that comes with a lot of technical, cultural and governance challenges. Working with Newcastle University has enabled Northumbrian Water to bring in the expertise that is required to help progress the project, including mathematical modelling, cyber physical systems and data management.

Case Study: Ocado

Bots are one of the main active components in Ocado's latest highly automated warehouses. Data science permeates all aspects of bot development and optimisation to enable huge efficiencies of scale, maximum throughput, and a constantly decreasing total cost of ownership.

By using well-curated data, data scientists with very little domain knowledge have built detectors to proactively identify elements of broken track on the grid and to direct maintenance engineers to the exact location. The company has also developed a machine-learning system that uses Fisheye CCTV cameras above the grid to cross-check bot locations with a control system that orchestrates the bots.

Another area where Ocado apply advanced AI and machine learning techniques is to dramatically improve their ability to predict deviations in the expected behaviour of bots. All the operational and sensor data from the bots is streamed to the cloud where a machine learning based healthcare system performs powerful predictive analytics and drives preventative maintenance.

Ocado also have data science teams currently working on a bot outlier detector. Built using Google WaveNet, this detector looks at lots of different time domain signals generated by parts of the bot, like the torque of the motors, to identify bots that are likely to experience technical issues in the immediate future. This critical capability allows them to extract maximum throughput from each bot - without removing a bot from the grid prematurely, while also proactively preventing failure for optimal operational efficiency.

This specific piece of work has been contributed to by two teams of data scientists (PhDs) in the UK and Sofia, with extensive academic research and experimentation and evaluation of different approaches. Moreover, their working practices and approach - including the architecture, tooling, and engagement with teams - enable this world-first R&D to be transferred to production seamlessly, while still allowing for experimentation. This exciting work would not be possible without the data engineering that is central to making sure the data is well-curated reducing the need for domain knowledge.

"The complexity of data-driven technologies often goes beyond the capabilities that businesses hold internally, compelling businesses to pursue collaborative innovation strategies."

The changing nature of R&D presents businesses with new challenges

The UK is home to many 'data native' businesses that are leading the world in data-driven R&D. They are using the opportunities these new capabilities bring to lead their industries, deliver for customers, and solve seemingly insurmountable challenges in new ways. These businesses are up and running but in a rapidly advancing environment and with strong domestic and international competition, it's tough to stay ahead.

Across the economy, these companies represent a minority. Many businesses are 'data novices'.[11] These businesses see the trends in data and analytics emerging around them but are still in the starting blocks and grappling with how to take the first step.

Across this spectrum there are also common challenges all businesses must overcome.

There is a diverse range of understanding within businesses of the value of the data they hold, with many unsure of the value or how to exploit it

Many UK businesses are not yet actively collecting potentially valuable data. Less than 10% of UK businesses use CRM to collect, store, and share customer information within their businesses.[12] However, there is an increasing awareness among many businesses that they could be sitting on mountains of valuable data. And they're right. Research suggests companies are currently only capturing a fraction of the potential value from data and analytics.[13] But 'data novices' lack the capacity or knowledge needed to unlock its potential value. Only 4% of companies report having the right people, tools, data and intent to be able to draw meaningful insights from data.[14] 'Data novices' need to get in the race.

'Data natives' are up and running but need to continually find new ways to use their data to improve services, tackle challenges and create new products if they're to remain internationally competitive.

There is a shortage of people with the specialist skills and competencies to ask the right questions and spot the opportunities

The first step is to understand what is possible and what capabilities are needed. Therefore, a significant constraint facing firms looking to grow their analytics capabilities is their ability to acquire the right talent.

> *"Just because you have the data, doesn't mean you can use it. Unless you have employees with an awareness of what techniques are out there, you are not aware of what is possible in the first place."*
>
> **CBI Member**

After identifying what talent and skills are needed, businesses are then finding that these skills are in short supply. In a recent CBI survey, data analytics skills were found to be one of the most in demand skillsets and one of the hardest to acquire with 37% of firms reporting that they are struggling to hire data analysts.[15] Shortages are particularly acute among large businesses where 61% of firms reported difficulties in hiring data analysts.[16]

With demand outstripping supply, individual businesses are faced with the challenge of how to attract highly sought-after talent. In many cases, although the skills being sought after are highly specialised, often they are sector agnostic. As a result, firms across sectors are fishing in the same pool for talent.

The implications of these shortages are significant. With 3 in 5 businesses also expecting demand to grow significantly in the next few years,[17] the UK is approaching a tipping point for data talent. In a competitive market where analytics skills can command high salaries, companies struggle to compete with the world's leading digital companies. Companies whose brands aren't known for providing exciting opportunities for employees to use their data and analytical skills find it hard to reach their target audience. Without action to increase the pool of talent, human capital could act as a major constraint on firms' ability to take advantage of the potential offered by data-driven innovation.

Collaboration is increasingly important to maximise the value of data, but many firms don't know how to strike up the right partnerships

Firms looking to exploit the value of their data but with limited capabilities in data analytics can gain a lot through pursuing collaborative innovation projects. Universities possess significant capabilities when it comes to data analytics; from state-of-the-art high-power computing facilities to advanced computer and analytics expertise and cutting-edge research. By working together in partnership, business and universities can combine their areas of expertise to apply world-leading knowledge and techniques to real world challenges to have significant impacts on society.

Businesses are increasingly approaching universities to help them unlock the potential value of their data for product and service development. However, businesses can find knowing where to start, and how to navigate a new and complex landscape challenging. Beyond initial discovery problems, the process of setting up collaborations can be difficult and time consuming. Processes differ between every university and sometimes between departments. Priorities often differ with businesses expressing concerns that too much focus is sometimes given to spinning out new start ups rather than trying to integrate broader industry.

This is well trodden ground. There are a range of tools and initiatives in individual universities as well as at network, local and national levels to make university-business collaboration easier. But for many businesses new to this territory, awareness is low.

Case Study: University of Leeds - Asda

Accessing expertise and having a real-world impact on sustainability through partnership

UK households waste 7.3 million tonnes of food every year. Asda wanted to understand and tackle this waste and gain a greater insight into their customer's attitudes and purchasing behaviours. They had a wealth of customer insight data but to make use of it they partnered with the Consumer Data Research Centre at The University of Leeds. An Associate was jointly recruited to fulfil the specialist skills required to deliver the 33-month initiative.

The University's strong reputation on sustainability research and the impact focus of its researchers, combined with Asda's data and consumer reach, positively influenced consumer behaviour, and helped deliver against national waste reduction targets.

Over 21 months, the team designed, executed and evaluated interventions based on insight from the data to influence customer behaviour. This multi-channel campaign provided customers with advice on food storage and labelling, to creative recipe inspiration for leftovers. Meanwhile, in-store events encouraged customers to pledge to make changes at home.

Two million customers made a change in their homes with 81 per cent planning to follow campaign advice. As a result of following the advice, customers benefit by saving on average £57 per year and the environment benefits from reduced food and packaging waste.

"Not only have we come away with real, measurable insight from shoppers but we've also seen the direct correlation between our recommended actions and tangible behavioural change."

Professor William Young, Consumer Data Research Centre, University of Leeds

The project also informed Asda's sustainability strategy with customers being put at the heart. Through this effective project, Asda colleagues now have greater access to cutting-edge research and can make better use of their data.

"We now have a greater understanding of customer attitude and behaviour, helping shape the way we communicate with our customers and ultimately the way we do business."

Andy Murray, Chief Customer Officer, Asda

Introducing new business models, strategies and investments pose new risks for businesses to manage

Innovation is inherently risky. It involves asking new questions and finding often unpredictable answers.

For established firms, the shift to data-driven R&D requires significant changes that introduce uncertainty, cost and risk across the business. Hiring people with new-to-firm skills and different expectations in company culture; investing in data sets and data infrastructure; repositioning your brand in the marketplace; changing business model, such as moving from a hardware to a software and service-based company. Businesses need to understand the opportunity, and identify what changes they need to make, but they also need to get their Boards, investors, shareholders and employees onboard. This holds true for new-to-world as well as new-to-firm innovation.

Although they may be more used to managing the risk, investing in such innovation is still a risk for 'data natives'. It's just that they recognise the risk of standing still is greater. The question is then not about whether they take the risk on, but where in the world provides the best environment to undertake this high-risk high-reward activity. Maintaining the effectiveness and competitiveness of the UK incentive offer amid technological change is therefore crucial.

Businesses also face the challenge of identifying R&D investment in digital technologies, such as AI and machine learning. Unlike in more traditional areas of R&D where projects are more easily defined, data-driven R&D often occurs through a series of iterative, incremental processes that do not always have an obvious start and finish point. They also tend to be focused on the 'D' of R&D. In the current policy context, businesses adopting data-driven practices could perversely risk not having their R&D recognised by incentive structures in the UK.

"There is an increasing awareness among many businesses that they could be sitting on mountains of valuable data. And they're right. Research suggests companies are currently only capturing a fraction of the potential value from data and analytics."

The UK must take action to harness the potential of new innovation trends

The UK needs to better position itself to take advantage of new innovation trends and attract innovative businesses. Government has made a first step by committing to raise UK investment in R&D to 2.4% of GDP by 2027, with a longer-term ambition to reach 3%. Bold and ambitious policy action is now needed to realise that target. Government must set out a comprehensive and future-focussed roadmap underpinned by an ambitious public funding settlement, forward thinking innovation policy and long-term alignment on skills.

Building the UK's strengths and capabilities around data and analytics must be a key feature of this strategy. Government, business and universities must take action to foster uptake and usage of data and analytics amongst the UK's data novices and ensure the UK remains a destination of choice for the world's data natives.

With bold, ambitious, forward-looking policy action the UK can capture the benefits of data-driven approaches to innovation, position itself as a global innovation frontrunner and take advantage of new growth opportunities. Without action, the UK risks falling behind in an accelerating global innovation race.

1. Set out a comprehensive and future focussed roadmap underpinned by commitments to raise public funding

Government must act on its commitment to delivering the 2.4% target by publishing a comprehensive roadmap. This roadmap must be underpinned by the necessary public funding to catalyse growth in UK R&D investment. If R&D investment continues at the current rate of growth the UK will not reach the 2.4% target until 2053, 26 years too late. Public investment in R&D crowds-in private investment, so government must take the lead.

Set out a long-term trajectory for government R&D expenditure

- At the upcoming Spending Review, Treasury should set out a commitment to public spending that is line with the ambition of the target.

Grow funding towards the development phase of R&D to support business innovation

- Business will have to do much heavy lifting to get us to 2.4% - but current support for business innovation is relatively underweight. The roadmap for raising investment in R&D should focus on growing funding for schemes that crowd-in business investment. For instance, response mode funding through Innovate UK, collaborative R&D, sufficient funding for existing catapults and strategic investment in later stage development such as capital-intensive pilot scale facilities and breakthrough tech.

2. Include measures to increase the number of businesses harnessing the potential of data and analytics in government's roadmap to 3%

To harness the potential of data-driven innovation, government must take action to foster uptake and usage of data and analytics amongst the UK's data novices. Low levels of adoption are rooted in a lack of awareness among businesses of the potential that data can offer and what steps they can take to exploit this value.

Develop and deliver a 'competency building' package to support businesses to understand and unlock value from their data

- Innovate UK should be resourced to develop a 'competency building' package focussed on supporting data novices to develop the capacities they need to understand and unlock value from their data.
- The Catapult network could be well placed to deliver this support to businesses in their regions and sectors. The package of support should focus on providing counselling, information, demonstration and mentoring services to businesses who are looking to exploit value from their data but who lack initial capacity and competencies to get started.
- In developing this programme, inspiration could be taken from Germany's 'Mittlestand 4.0 Competence Centre' programme[18] and America's 'Small Business Development Centres',[19] which have been developed as mechanisms to support the diffusion and adoption of technology throughout the economy.

3. Make it easier for businesses to navigate innovation support and strike up productive partnerships

Businesses consistently cite challenges in navigating the complexity of UK innovation support network and many are not aware of what support or collaborative opportunities are out there. Due to the changing nature of R&D, there are many businesses undertaking data-driven innovation outside of the traditional audience for government R&D support. To address awareness challenges, innovation authorities and universities need to take more proactive approach to reaching business audiences.

Establish a new 'business advisory group' for UKRI

- Create a new business advisory group as a channel to inform strategy and policy development. This mechanism could help ensure that innovation support is keeping pace with business priorities and needs.

Implement a business development and outreach function in Innovate UK

- Fund and resource Innovate UK to set up a new outreach function focussed on reaching business audiences that have not engaged with Innovate UK before and to support the development of those with potential but who have been unsuccessful in funding applications or don't fit existing calls.
- The UKRI business advisory group could inform and co-create an effective communication and outreach strategy. This should support navigation of UKRI and wider government innovation opportunities.
- Other key actors who Innovate UK could collaborate with to spread awareness of support include incubators, accelerators, universities and Local Economic Partnerships.

Increase visibility and simplicity of government and university innovation support

- Government should create a 'digital shop window' that clearly outlines and sign-posts the range of innovation support across government that businesses can access.
- The platform should also be designed to showcase and market the competitiveness of UK innovation support to international as well as domestic businesses. Doing more to market the UK's innovation offer can be used as a way to drum up new investment and compete globally.
- Universities should put in place well-resourced points of entry as a way to help improve accessibility and connect businesses with expertise. By having a clear 'front door' universities can help to enhance engagement with businesses.

4. Position the UK as a global leader in data-driven R&D by setting out ambitious and creative policy

To remain a destination of choice for the world's data natives the UK should embrace new experimental policy approaches and ensure policy instruments remain effective in response to the changing nature of R&D. Other countries are already adapting their innovation policy approaches and experimenting with new policy instruments.[20]

Deliver the world's most competitive R&D tax credit by ensuring that it recognises the growing importance of data-driven R&D

- The UK's R&D tax credit scheme is relatively generous by OECD standards.[21] However, tax incentive support represents a rapidly evolving area of policy with governments constantly seeking to reform the generosity, efficiency and structure of their schemes. And technological developments present new challenges for tax policy. Although software acquisitions and their maintenance costs are included with the R&D tax credit, businesses adopting more data-driven R&D practices are finding that their R&D activities are not recognised by incentive structures in the UK. With government committing to put the UK at the forefront of the AI and data revolution it is important that it ensures that the tax incentive regime recognises the growing importance of data-driven R&D.
- Treasury should ensure the R&D tax credit evolves to reflect the reality of modern technologies and data-driven innovation. Treasury should consider amending definitions of eligible activities to include the costs of purchasing, storing, using and analysing data which have been used in driving R&D and innovation in the UK.

Embrace experimental policy approaches

- Shifting innovation trends create new challenges for public policy. This in turn requires experimental policy approaches. In order to pitch itself at the international top tier, government must also adapt and experiment.
- Government should not be afraid of trying new experimental approaches to supporting innovation. The Business Basics fund – a fund supporting the adoption of tried and tested technologies in small businesses – is a good example of this in practice and illustrates how new approaches can be trialled and used to inform future policy decisions before strong policy measures are implemented.
- Transparency and proactive engagement with business should be built in to the design of new approaches.

5. Grow the UK's capability and capacity in high-level data and analytics skills

Businesses are acutely aware that people are the driver behind R&D. In this new paradigm, the competition between firms intensifies as businesses are looking to attract the same sector-agnostic talent. The CBI's work on digital skills and the National Retraining Scheme are essential foundations to build on over the long-term.

Ensure the Government's retraining scheme has digital skills embedded, including targeted support for software engineering and data analysis skills

- The development of the National Retraining Scheme should continue to be informed by employer evidence on digital skills shortages. Across small, medium and large businesses, advanced digital skills needs are set to grow rapidly. The National Retraining Scheme is well placed to collaborate with employers and employees to address the acute shortage in software engineering and data analytics skills.

Communicate skills needs across government

- Innovation authorities should inform education policy makers about the skills needs that are arising with technological change.
- A joined-up approach across government can help to ensure that future phases of education programmes are geared towards ensuring a necessary long-term approach to developing skills.

Use management KTPs to increase management capabilities in data

- In the 2018 budget government announced new funding to extend the Knowledge Transfer Partnerships scheme to support the development of business management capability. One area that new management KTPs could focus on is supporting business awareness and understanding of how they can use data.

Government, business and universities must take action to foster uptake and usage of data and analytics amongst the UK's data novices and ensure the UK remains a destination of choice for the world's data natives.

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Produced by Ollie Diss and the Innovation team
To share your views on this topic or ask us a question, contact:

Ollie Diss
Policy Adviser
ollie.diss@cbi.org.uk

www.cbi.org.uk