Department for Science, Innovation & Technology

Making Innovation Matter

How the UK can benefit from spreading and using innovative ideas

BEIS/DSIT Research Paper Number 2023/009

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Making innovation matter - executive summary

Introduction

Innovation is a key Government priority[1]. It has long been assumed that increased investment in research and development (R&D) will efficiently flow through into creating innovative products and services that will benefit the UK economically and socially. In reality, the process and relationship between increased funding and successful innovation is not so linear[2].

While the UK is world-leading at R&D and creating start-ups around new ideas, it lags behind many other countries when it comes to getting great ideas to market.[3] For the benefits of increased investment into R&D to be realised, barriers to spreading innovation (diffusion) and increasing the uptake of innovation (adoption) should be better understood and addressed. This will support the government's vision to make the UK a global hub for innovation.

Making Innovation Matter

Working in partnership with the Department for Science, Innovation and Technology's (DSIT) predecessor BEIS, PA Consulting (PA) has mapped the UK innovation ecosystem, defined a model for innovation diffusion and adoption and compared the UK's performance with OECD comparators. Based on this data, a range of stakeholders across industry, academia, start-ups, scale-ups and consumers have been engaged to identify and understand the key barriers to innovation diffusion and adoption (IDA).

Inputs to this report include: a systematic literature review and meta-analysis of over 150 research papers, white papers and books; interviews and input from almost 100 innovation experts; additional commentary from a roundtable event; and data gleamed from a proprietary research survey of over 500 innovation leaders.

The aim is to provide an evidence-base to better understand innovation diffusion and adoption in the UK, the barriers to increasing spread and uptake of innovation and what further research or potential solutions should be explored.

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1 UK Innovation Strategy: leading the future by creating it (accessible webpage) - GOV.UK (www.gov.uk)

2 See section 1.5 for more information on how different countries perform on innovation outcomes versus spending.

3 ibid

Key findings for IDA

Innovation diffusion and adoption takes place within a fragmented, complex and poorly intra-connected ecosystem. There are many different stakeholders, organisations and structures influencing IDA. Funding, praise, status and incentives are often centred around having and owning an idea as opposed to its successful application at scale.

A lack of incentive is compounded by the different skillsets required to support an idea through the early majority stage of innovation. Academic know-how must be combined with entrepreneurial vision, appetite for risk, investment, marketing, sales, logistics and customer service. Taken together otherwise successful innovations fail to make it beyond early adoption because stakeholders are not properly incentivised to go to market and/or do not have the skills to do so.

Government and Business have already acted to address this issue with a wide range of institutions, accelerators, funds and initiatives to support innovation[4]. Whatever the merits of existing and planned initiatives it is clear from both international experience and domestic data that more can be done, particularly around identifying priorities and challenges, setting out roadmaps with clear direction, using its buying power as anchor customers, and creating the right funding and regulatory environment to enable innovation to thrive.

Opportunities to better understand and improve IDA include:

1. Inspire stakeholders and communities to address key innovation challenges in an open and inclusive way, giving them freedom to experiment, with Government taking more of the lead by setting concrete direction.
2. Invest in skills (both innovation skills and specialist skills such as in STEM, business, research and professional expertise) and drive collaboration at all levels, including leadership and skills development.
3. Broaden the diversity of participation and perspectives and build trust.
4. Develop a more joined-up ‘supply chain’ approach, with cross-sector fertilisation of ideas and technologies, and place-based specialisms, creating ‘hubs’.
5. Increase funding for diffusion and adoption activities such as improving public sector procurement with multi-year grants for innovations that ensure emphasis on IDA.
6. Target support for IDA activities, including better metrics

4 UK Innovation Strategy: leading the future by creating it (accessible webpage) - GOV.UK (www.gov.uk)

Conclusions

There is opportunity to realise greater returns on the UK's R&D investment through a concept to consumer approach to innovation; focusing on key challenges and incentivising all stakeholders to collaborate as part of a cross-sector, cross-discipline innovation supply chain to take ideas from concept to application at scale. By better understanding IDA and proactively exploring potential solutions, Government can act as force-multiplier and deliver the vision of the UK as a global leader in innovation with associate benefits for productivity, output and quality of life.

Contents

1 Innovation diffusion and adoption in the UK today

Why is innovation important for the UK? Innovation will be critical to solve many of the big social and environmental challenges facing the world – from sustainable food production to clean water, climate change (drivers of global migration), and creating new ways for us to live, communicate and work. Innovation improves and saves lives: innovations in medicine have doubled the average person's life span5. Innovation is a driver for economic growth, playing a vital role for the UK's future prosperity and improving productivity, including creating more and better-paid jobs as part of the Government's 'Levelling up' agenda. Science, technology and innovation are Government priorities.

What is this report about? The aim of this report is to provide an evidence-base to understand the situation of innovation diffusion and adoption in the UK and the barriers to increasing spread and uptake of innovation. There is a huge amount of research looking at the early stages of the innovation lifecycle – how new ideas are created or discovered, how inventions are made and developed, and how new products are brought to market. This report focuses on a less-well covered area of the innovation lifecycle: how innovations are diffused (communicated or spread) and adopted (brought into widespread use) in the UK.

There are three main sections to the report:

- Section 1: Explores the 'state of the nation' – that is, how IDA happens in the UK at the present moment, different theories and models, its current effectiveness level, international comparators; and the barriers to IDA success.
- Section 2: Identifies gaps and possible solutions for future IDA in the UK, setting out what the UK can do to improve practice and outcomes – and to prove it through measurement.
- Section 3: Sets immediate next steps and an indicative path to support the increase of IDA.

5 BEIS. (2021). Evidence for the UK Innovation Strategy.

1.1 What is innovation diffusion and adoption?

Innovation is ‘ideas, successfully applied’. IDA are interrelated processes where diffusion is a ‘push’ or spread of ideas, and adoption is a ‘pull’ or uptake of ideas. These processes occur within a complex ecosystem from which ideas can emerge, become widespread, and result in social change.

1.1.1 Definitions

There is no single agreed definition of ‘innovation’. In this report PA has defined innovation as ‘ideas, successfully applied’[6].

The OECD Oslo Manual defines innovation as: “a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products of process and that has been made available to potential users (product) or brought into use by the unit (process)”[7].

Importantly, both definitions take the view that ‘innovation’ must be made available (diffused) and applied or used (‘adopted’) to be considered innovation: this report focuses on the processes and factors which relate to this part of the definition.

Whether innovations contribute to economic growth and positive social change will be determined by the rate and manner of IDA by the target population, organisation(s), or market. Innovation ‘diffusion’ is the “process by which an innovation is communicated through certain channels over time among the members of a social system”[8]: a special type of communication in that the messages are concerned with new ideas, ultimately forming a new ‘norm’.

The four main building blocks of this process are: innovation, communication channels, time and the social system. Innovation ‘adoption’ is the ease with which a new idea, product or service becomes applied, or used, leading to impact such as social change, or a new technology becoming ubiquitous: “When new ideas are invented, diffused, and are adopted or rejected, leading to certain consequences, social change occurs”[9].

Unlike most definitions of diffusion which focus on the diffusion of ideas across society, this report focuses on diffusion in businesses and in the wider society. Throughout this report PA has considered ‘diffusion’ and ‘adoption’ as separate but inter-related concepts, in which diffusion (spread) needs to happen before an innovation can become adopted (come into widespread use) – although there are

6 Dodgson, M. and Gann, D. (2010) Innovation: A very short introduction. Oxford University Press.

7 OECD/Eurostat (2018), Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities, OECD Publishing, Paris/Eurostat, Luxembourg, https://www.oecd.org/sti/inno/oslo-manual-2018-info.pdf

8 Rogers, E. M. (1962) Diffusion of Innovations, First Edition. The Free Press.

9 Rogers, E. M. (1995) Diffusion of Innovations, Fourth Edition. The Free Press.

also feedback loops operating where the more people adopt an innovation, the more widely spread it becomes. Diffusion can often be very slow, while adoption can be highly variable[10].

1.1.2 The ecosystem

Innovation often relies on an 'ecosystem' – a complex interconnected network of relationships – from which new ideas can emerge, and an innovation 'system' by which those ideas can be pulled through or exploited – for example through processes of commercialisation. There is no one definition of an 'innovation ecosystem', but descriptions often focus on a biological ecosystem analogy[11] and on value creation rather than value capture[12]. Innovation ecosystems are seen as being comprised of two subsystems: the knowledge economy (academic and industry research), and the commercial economy6 which translates outputs from the research economy into commercially viable products and processes for consumers. A thriving open innovation ecosystem removes barriers[13] through alignment and shared incentives[14].

Innovations can have great benefit but also cause harm: they can affect different groups in different ways at the same time (for example automation could lead to greater efficiency but even if temporary could lead to job loss until more jobs are created). Embarking on innovation is therefore not neutral or unequivocally good – but is often necessary and sometimes unstoppable. Innovations are not diffused/adopted in isolation, as past experiences influence how the next innovation is received. There can therefore be a climate conducive for innovation when 'the time is right'.

Innovations can also become modified and used in ways that were not originally intended, or not for their originally intended purpose. Often the pathway for individual innovations to become adopted are not smooth, logical, or even sequential. Instead, innovation is often an unstructured, emergent phenomenon which is rarely – if ever – linear.

Figure 1: How innovation really works, showing success (solid line) and failure (dotted line).

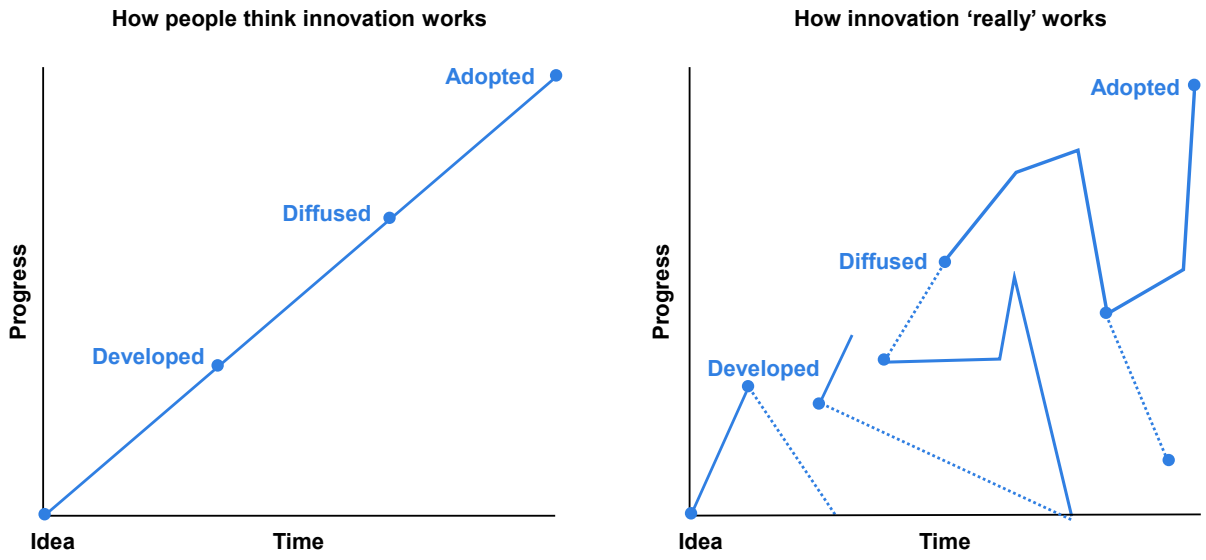
10 Hall, B. H. (2004). Innovation and diffusion.

11 Jackson, D. J. (2011). What is an innovation ecosystem? National Science Foundation, 1(2), 1-13.

12 de Vasconcelos Gomes, L. A., Facin, A. L. F., Salerno, M. S., & Ikenami, R. K. (2018). Unpacking the innovation ecosystem construct: Evolution, gaps, and trends. Technological forecasting and social change, 136, 30-48.

13 Chesbrough, H., Kim, S., & Agogino, A. (2014). Chez Panisse: Building an open innovation ecosystem. California management review, 56(4), 144-171.

14 Traitler, H., Watzke, H. J., & Saguy, I. S. (2011). Reinventing R&D in an open innovation ecosystem. Journal of food science, 76(2), R62-R68.



Source: PA

1.2 How does innovation diffusion and adoption happen?

IDA is a part of a highly complex ecosystem. Ideas start with the innovators and are initially taken up by early adopters: there is a 'chasm' between this population and the 'early majority', where the innovation becomes widely adopted. To bridge the chasm, the innovation must move from one kind of market to a completely different market segment. This can be hindered by many barriers, leading to often discontinuous or failing adoption pathways.

1.2.1 The Rogers Adoption Curve

The IDA ecosystem has several key characteristics: it is highly complex; can be unpredictable; and has multiple actors (individuals, organisations, entities) with different aims and perspectives. The Rogers Adoption Curve (also called the Diffusion Process)[15] describes how new innovations and ideas are accepted and adopted over time sequentially by groups and cultures.

The curve shows how in any group of people, a small number will be enthusiastic 'innovators' coming up with new ideas, with a desire for the new and different. A minority will be 'early adopters' who enjoy trying new technologies and act as trendsetters. Many innovations get stuck at this point. If they make it across 'the chasm'[16], the innovation may be adopted by the 'early majority' – the largest segment made of pragmatists who will adopt new innovations only once proven and

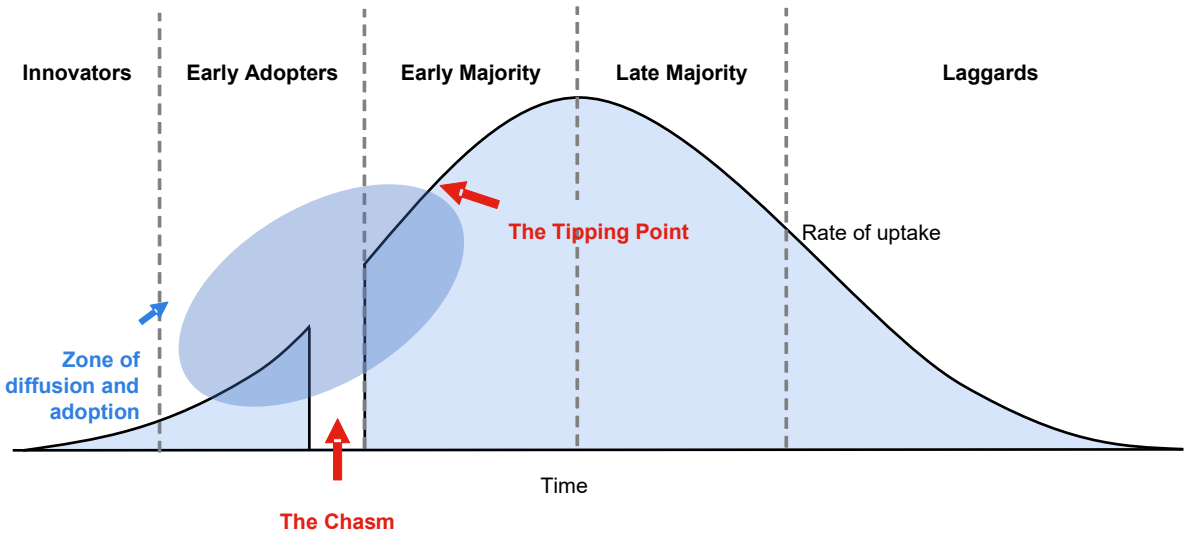
15 Rogers, E. M. (1995) Diffusion of Innovations, Fourth Edition. The Free Press.

16 Moore, G. A. (2002). Crossing the chasm: Marketing and selling high-tech products to mainstream customers (Revised edition ed.). New York: Harper Collins.

they feel comfortable with them. The 'late majority' are another large group, of more cautious, risk averse people who need reassurance to overcome barriers to adopting new innovations. A final small group are the 'laggards' who will only use the innovation if at last resort, and with reluctance.

The Zone of Diffusion and Adoption focuses on how innovations bridge the Chasm and make the jump into widespread adoption by the early majority – after which point the momentum of take-up becomes unstoppable (the Tipping Point). There is some evidence that the pace of innovation adoption has become, on average, faster in recent years, enabled by developments such as the internet, which have helped to disseminate new ideas more rapidly[17]. The COVID-19 pandemic has also accelerated innovation in many areas: for example, the adoption of digital technology across the NHS, with 99% of GP practices now using remote channels to triage patients before offering appointments, and nearly half of GP appointments now happening over video and phone calls.

Figure 2: The Diffusion Process (adapted from Rogers Adoption Curve).



Source: PA

1.2.2 Zone of Diffusion and Adoption

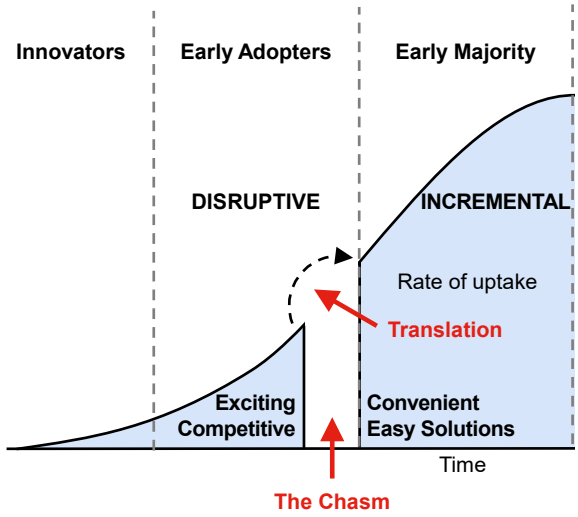
This report focuses on the Zone of Diffusion and Adoption that bridges the chasm; specifically, how innovations gain traction and become successful. Each side of this chasm has a very different constituency: early adopters and the early majority. The first group are enthusiastic advocates, motivated by novelty, who will accept some pain and inconvenience in exchange for a competitive edge, or status. The second group want evolution rather than revolution and expect things to work without

17 Alwaer, H., Beltrán, F., Clements-Croome, D. & Melo, D. (2013). Intelligent Buildings: Design, management and operation, Second Edition. ICE Publishing.

glitches – they require proven, easy solutions[18]. That means to bridge the chasm, the innovation must move from one market to a completely different market segment.

Furthermore, the second group does not trust the decisions of the first group, so their advocacy has little impact and the early majority look to each other to validate their choices. It may be relatively simple for an innovation to meet with early success among the 'first mover' early adopter customer base, but it is much harder to reach the early majority, leading to complicated and discontinuous adoption pathways unless there is effective translation between the two populations.

Figure 3: Jumping the chasm through translation.



Source: PA

18 Moore, G. A. (2002). Crossing the chasm: Marketing and selling high-tech products to mainstream customers (Revised edition ed.). New York: Harper Collins.

1.2.3 Succeed or fail

Paying attention to why and how innovations fail to become adopted can help explain the factors for successful adoption[19]. Failure is much more likely than success – most start-ups fail, and most patented ideas are not translated into products and launched services. In 2019, the one year survival rate of UK businesses was 88.3%, and only 39.6% of businesses survived to their fifth year[20] – while 97% of patents never make any money[21]. New-product failures account for 40% to 90% of new product innovations[22] due to flawed products, poor timing, or poor business decisions (noting that many pointed to the importance of learning from failure as key to innovation[23]).

> **Survey spotlight**: PA's global 'Innovation Matters' survey showed that failing fast is important: 54% of successful innovators consider the ability to kill projects a core strength, compared to 40% of less successful peers.

Other blockers to IDA include supply chain problems[24], active resistance (negative attitudes)[25], lack of awareness and understanding[26], high initial costs, risk aversion and high complexity, as well as the struggle to generate perceived need[27].

Technologies and their specific barriers to diffusion and adoption:

The adoption and diffusion of different technologies face unique barriers which can impede progress. The rapid adoption of contactless payments as compared to electric vehicles exemplifies these differences and points to there being no single silver bullet for rapid adoption and diffusion.

19 Bauer, R. (2014). Failed Innovations — Five Decades of Failure?" Icon, vol. 20, no. 1, International Committee for the History of Technology (ICOHTEC), 2014, pp. 33–40, http://www.jstor.org/stable/23788086.

20 ONS. (2020). Business demography: 2020 Retrieved 22 April 2022, from https://www.ons.gov.uk/businessindustryandtrade/business/activitysizeandlocation/bulletins/businessdemography/2020

21 Key, S. 97% of All Patents Never Make Any Money. Retrieved 1 April 2022, from https://www.allbusiness.com/97-percent-of-all-patents-never-make-any-money-15258080-1.html

22 Mahajan, V., Muller, E., & Wind, Y. (Eds.). (2000). New-product diffusion models (Vol. 11). Springer Science & Business Media.

23 Välikangas, L., Hoegl, M., & Gibbert, M. (2009). Why learning from failure isn't easy (and what to do about it): Innovation trauma at Sun Microsystems. European Management Journal, 27(4), 225-233.

24 Gupta, H., Kusi-Sarpong, S., & Rezaei, J. (2020). Barriers and overcoming strategies to supply chain sustainability innovation. Resources, Conservation and Recycling, 161, 104819.

25 Joachim, V., Spieth, P., & Heidenreich, S. (2018). Active innovation resistance: An empirical study on functional and psychological barriers to innovation adoption in different contexts. Industrial Marketing Management, 71, 95-107.

26 Mani, Z., & Chouk, I. (2018). Consumer resistance to innovation in services: challenges and barriers in the internet of things era. Journal of Product Innovation Management, 35(5), 780-807.

27 Curtius, H. C. (2018). The adoption of building-integrated photovoltaics: barriers and facilitators. Renewable Energy, 126, 783-790.

Example: Contactless payments

In the UK, 13.1 billion contactless payments were made in 2021: 69% of all debit card payments. Diffusion of this technology was accelerated by the COVID-19 pandemic, with many vendors taking the decision to move to contactless-only payments for public health reasons to reduce the spread of the virus. The technology was, however, first launched in the UK in 2007, and was the result of extensive development and testing for security and useability, meaning that when the pandemic struck, it was already on the cusp of a ‘network effect’ or tipping point for widespread adoption. Several factors were key to success:

The integration of contactless payments into existing infrastructure by Transport for London, replacing Oyster cards as the main means of payment for routine travel.

Good user engagement, with convenience and speed as key benefits, plus high visibility of others using the new technology.

Confidence in security and safety, with banks being trusted to manage payments successfully and low fraud rates.

Example: Electric Vehicles

Reducing the use of diesel and petrol is a key part of the UK Government's plan to achieve net zero goals in 2050, with a target to end the sale of new petrol and diesel cars from 2030 onwards. While the Government has set a clear and ambitious target and vision, and has invested in R&D to develop e-vehicles (EV), uptake has been relatively slow. The stock of EV public charging infrastructure nearly doubled in the two years to the end of 2020, but lack of charging points remains a key barrier, with only 29,600 public charge points in the UK. The Government has set a new target to increase the number of electric car chargers to 300,000 by 2030. Uptake has been hindered by:

Regional variation, with most of the EV charging points located in London but relatively few in the North-West of England, Yorkshire and Northern Ireland. These have not yet reached the tipping point where uptake becomes endemic.

Wealth inequalities, as new EV are expensive to buy and are often bought as second cars in addition to petrol or diesel cars: installing charging points at home is another upfront expense, and benefits people with houses large enough for driveways.

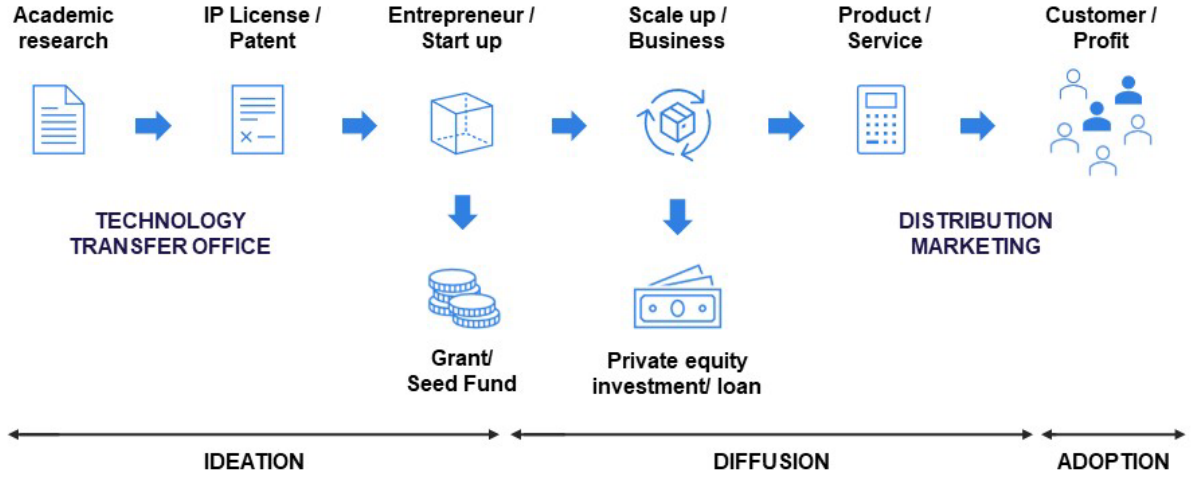
1.2.4 Private and public sector models

In the technology transfer/profit-driven model for innovation diffusion, academics become entrepreneurs, or entrepreneurs take ideas and transform them into products and service, scaling up to bring them to market and create growth and jobs in the process. Innovation enables businesses to create new sectors, enter new markets, reduce production costs, and produce more output with the same inputs. In this model, innovations focused on achieving market success/monopoly are likely to

be biased towards the needs of affluent consumers. National innovation policies tend to be more oriented towards (quantifiable) economic growth, while sitting alongside goals such as social change, sustainability, equality, or improving more people's lives.

Technology transfer prioritises the creation and protection of Intellectual Property (IP). IP is seen as both an enabler of IDA (since it gives the innovator a way to profit from their idea) and an inhibitor of innovation[28] by restricting candid discussions, open innovation collaboration, and knowledge sharing, therefore making it more difficult for third-party or external support to scale up ideas[29]. Taking out a patent can protect an idea and guard future revenue, however, there are several reasons for why some people perceive it as unhelpful and choose not to patent their idea to keep it secret. Patents can be hard to enforce – especially internationally, patenting is also an expensive and slow process. Instead it can be better to rapidly determine if an idea has the potential for market success first.

Figure 4: The 'idealised' technology transfer lifecycle for private sector innovation.



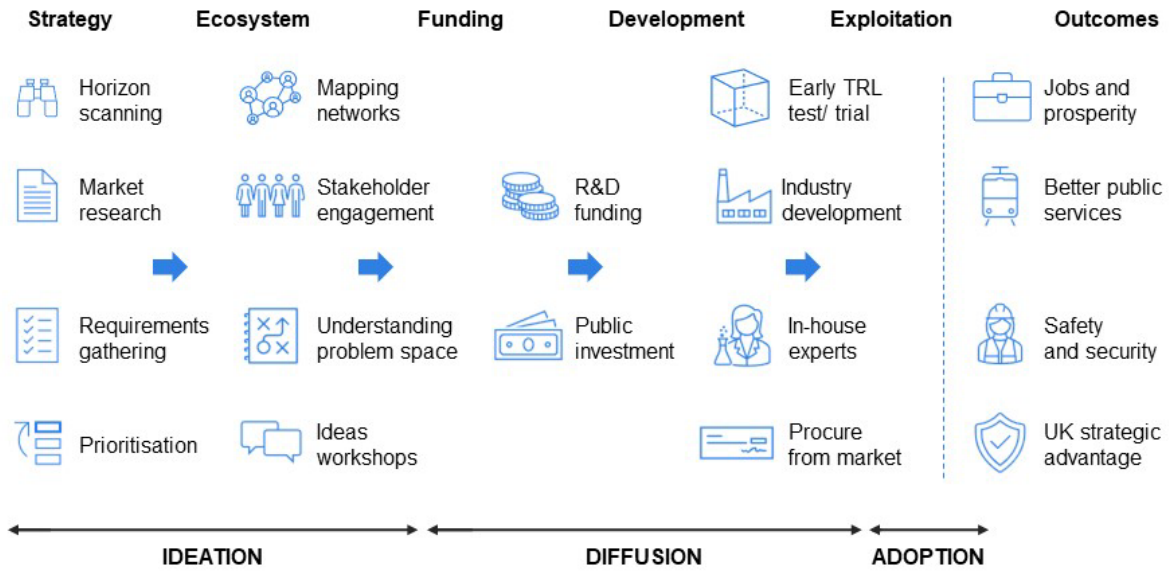
Source: PA

28 Alexy, O., Criscuolo, P., & Salter, A. (2009). Does IP strategy have to cripple open innovation? MIT Sloan management review, 51(1), 71.

29 National Academies Policy Advisory Group, London (United Kingdom);. (1995). Intellectual property and the academic community.

This compares to the public sector innovation lifecycle, which can involve many more elements, stakeholders, stages, and different kinds of desired outcomes:

Figure 5: Public sector innovation.



Source: PA

1.2.5 Product or service-based innovation

Often innovations are not about creating new products, but developing, adopting and assimilating improved processes to decrease costs, enhance quality, improve performance, or gain a competitive edge. In these instances, IDA depend heavily on organisational characteristics and openness to change. Success factors for these kinds of innovation becoming diffused include awareness and perceived benefits (such as external peer-pressure), while adoption can depend on cultural factors and incentives.

More than 75% of the UK economy is service-based but innovation in services is less visible, and less well defined and quantified, than product innovation[30]. The traditional indicators of innovation inputs (such as levels of R&D expenditures) and innovation outputs (such as the number of patents) suggest that services are less innovative than other branches of the economy. However, service and business model innovation may simply be less visible using traditional metrics. During the COVID-19 pandemic lockdowns, virtual service provision became critical in many areas, leading to a rush to develop innovative service and business models[31] and an

30 Abreu, M., Grinevich, V., Kitson, M., & Savona, M. (2010). Policies to enhance the 'hidden innovation' in services: evidence and lessons from the UK. The Service Industries Journal, 30(1), 99-118.

31 Breier, M., Kallmuenzer, A., Clauss, T., Gast, J., Kraus, S., & Tiberius, V. (2021). The role of business model innovation in the hospitality industry during the COVID-19 crisis. International Journal of Hospitality Management, 92, 102723.

uptake in the use of online services including banking[32], largely due to shifts in perceptions of risk. Many businesses responded to the COVID-19 pandemic by accelerating their innovation – moving to online service provision and adopting new remote management practices[33]. Digitisation became critical for many businesses' survival[34].

Some innovations are aimed at bringing about beneficial social and individual changes in behaviours, such as wearing seatbelts, stopping smoking, or losing weight. Innovation literature often has a socio-technological, socio-economic, or anthropological methodology and theoretical lens, which explores the role of individuals, communities, groups and society on IDA across many cultures.

An influential concept has been the 'meme' coined by Richard Dawkins in 1976 as a cultural parallel to genes, which describes how ideas and behaviours can spread[35]. It has since been appropriated to describe viral sharing through the internet[36]. Imitation (and modification) is key to this spread of ideas, and that entails becoming aware of something (visibility) from a source one is likely to listen to – crucially, the idea may spread for its own benefit or for wider social benefits and not necessarily the benefit of the individual[37].

IDA Survey: We asked people what their trusted sources of information were, which are key to innovation diffusion. The top three were: professional networks (22.9%), research institutes (13.1%) and new disrupters/ small businesses (12.6%). Government was the least trusted option. Industry subject-matter experts and their professional networks are key to the spread of innovative technologies, products, and services.

32 Yan, C., Siddik, A. B., Akter, N., & Dong, Q. (2021). Factors influencing the adoption intention of using mobile financial service during the COVID-19 pandemic: the role of FinTech. Environmental Science and Pollution Research, 1-19.

33 Riom, C., & Valero, A. (2020). The Business Response to Covid-19: the CEP-CBI survey on technology adoption. Centre for Economic Performance, London School of Economics and Political Science.

34 Akpan, I. J., Soopramanien, D., & Kwak, D. H. (2021). Cutting-edge technologies for small business and innovation in the era of COVID-19 global health pandemic. Journal of Small Business & Entrepreneurship, 33(6), 607-617.

35 Dawkins, R., & Davis, N. (2017). The Selfish Gene. Macat Library.

36 Nast, C. (2022). Richard Dawkins on the internet's hijacking of the word 'meme'. Retrieved 1 April 2022, from https://www.wired.co.uk/article/richard-dawkins-memes

37 Blackmore, S., & Blackmore, S. J. (2000). The Meme Machine (Vol. 25). Oxford Paperbacks.

1.3 Is the UK good at innovation?

The UK has a distinguished history of world-leading innovation and is a global leader thanks to its research base, thriving start-up sector, enabling environment, and investor community. However, the UK's R&D spend lags behind its international counterparts, and evidence for strengths and weaknesses in IDA is variable, with many myths.

1.3.1 The UK is a world-leading innovation nation

The UK has a long history of inventions, research and R&D across many areas of science and technology. It encompasses Isaac Newton's creation of the reflecting telescope in 1668, electric motors (Michael Faraday, 1821), railways (George Stephenson, 1825), telegraphs (Charles Wheatstone and William Cooke, 1837), telephones (Alexander Graham Bell, 1876), the steam engine (patented by Thomas Savery in 1668 and developed over subsequent centuries by James Watt and Richard Trevithick), light bulbs (Joseph Swan, 1879), stainless steel (Harry Brearley, 1913), tanks (Ernest Swinton, 1914), jet engines (developed by Frank Whittle between 1928 – 1937), hovercrafts (Christopher Cockerell, 1953), the structure of DNA (James Watson and Francis Crick, 1953), the worldwide web (Tim Berners-Lee, 1989), cloning (Keith Campbell, 1996), graphene (Andre Geim and Kostya Novoselov, 2004), and a vaccine as part of the global effort against the COVID-19 pandemic (University of Oxford and Astra Zeneca, 2020).

The UK is a leader in global innovation: in 2020 the UK ranked fourth highest among the 131 countries featured in the Global Innovation Index[38]. This is mainly thanks to our research base, start-up sector, enabling environment, and investor community:

- **The UK has a strong research base[39]:** The UK's world-leading research base includes 90 world-ranked universities, including four in the top 10 in 2022[40] (University of Oxford, University of Cambridge, Imperial College London, and UCL), and it is the world leader in the quality of scientific publications[41]. However, the UK invests a lower percentage of GDP in R&D than its competitors including South Korea (or Republic of Korea), Japan, Germany, the US, Finland[42]. Businesses in the UK also have below-average

38 WIPO. (2020). Global Innovation Index 2020 - United Kingdom [Ebook]. Retrieved from https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020/gb.pdf

39 Department of Business, Innovation and Skills. (2011). International Comparative Performance of the UK Research Base - 2011 [Ebook]. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/32489/11-p123-international-comparative-performance-uk-research-base-2011.pdf

40 Lane, C. (2022). Top Universities in the UK 2022. Retrieved 1 April 2022, from https://www.topuniversities.com/university-rankings-articles/world-university-rankings/top-universities-uk-2022

41 BEIS. (2019). International comparison of the UK research base, 2019. https://www.gov.uk/government/publications/international-comparison-of-the-uk-research-base-2019

42 The Royal Academy of Engineering. (2022). Investing in UK R&D [Ebook]. Retrieved from https://www.raeng.org.uk/publications/briefings-statements-letters/investing-in-uk-r-d-2022-update

investment in R&D[43]. This reflects a growing tendency for businesses to move away from in-house R&D and to outsource this instead to university partners (primarily funded by the public purse) for new ideas that could lead to be commercialised to create new profitable products.

- **The UK has a thriving start up sector:** The UK is one of the easiest places in the world to start a new business, reaching a record high of over 770,000 new businesses in 2020 (up 13.25% since 2019)[44]. In 2019, the UK had 33,445 scale-up firms (with a 20% annual increase in revenue or employees), employing over three million people and generating a total turnover of £1.1 trillion for the UK economy[45]. The UK has over 200 innovation accelerators supporting thousands of new businesses every year[46]. The UK hosts four of the world's top 100 science and technology clusters: London (15th), Cambridge (57th), Oxford (71st) and Manchester (93rd). Cambridge and Oxford are also the most science and technology-intensive clusters in the world.
- **The UK's enabling environment** includes its strong global brand and reputation. Adherence to ethical and social values is strong in both public and private sectors, leading to a strong regulatory and legal environment[47]. The UK has a global reputation as a safe and honest place to do business, with good adherence to the rule of law.
- **The UK's investor community is well linked to R&D and technology transfer mechanisms:** the UK has a thriving entrepreneurial ecosystem and is the leading place in Europe to start a new business[48]. UK tech VC investment is third in the world, hitting a record high of $15bn in 2020[49] and hit record levels of VC investment in 2021 of over £29.4bn[50]. However, there is evidence to suggest VC for Scale-ups is not as effective in the UK.[51] Investment capital is heavily concentrated in London and sectors such as ICT, biotech, and healthcare. This small, elite investment area, driven by university heritage international appeal, lacks regional and participatory diversity, while also continuing a vicious cycle of exclusivity. There is also some evidence that start-ups headed by women or people from different ethnic backgrounds can

43 The UK Innovation Report 2021. (2021). Retrieved 1 April 2022, from https://www.ciip.group.cam.ac.uk/uk-innovation-report-2021/

44 The CFE business startup index - Centre for Entrepreneurs. Retrieved 1 April 2022, from https://centreforentrepreneurs.org/cfe-research/business-startup-index/

45 Scaleups: energising the economy. (2021). Retrieved 1 April 2022, from https://www.scaleupinstitute.org.uk/wp-content/uploads/2021/11/1598_SUI_AR21_Infographic_Summary_Final_Web_Updated.pdf

46 Business incubators and accelerators: the national picture. (2017). Retrieved 1 April 2022, from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/955469/business-incubators-accelerators-uk-report.pdf

47 Scholten, V. E., & Blok, V. (2015). Foreword: Responsible innovation in the private sector. Journal on Chain and Network Science, 15(2), 101-105.

48 UK tech startups and scaleups to watch in 2021 | Sifted. (2021). Retrieved 1 April 2022, from https://sifted.eu/rankings/uk-startups-top-rankings

49 Tech Nation Report 2021 - Tech Nation. (2021). Retrieved 1 April 2022, from https://technation.io/report2021/#key-statistics

50 UK tech sector achieves best year ever as success feeds cities outside London. (2021). Retrieved 1 April 2022, from https://www.gov.uk/government/news/uk-tech-sector-achieves-best-year-ever-as-success-feeds-cities-outside-london

51 Economist (2022), Britain is a great place to start a company but a bad one to scale it up. https://www.economist.com/britain/2022/06/21/britain-is-a-great-place-to-start-a-company-but-a-bad-one-to-scale-it-up

struggle to get investment: between 2009 and 2019 only 2.87% of capital raised across the seed, early and late venture stages went to all-female teams (with mixed gender teams securing 12.51% and all-male teams 84.17%). All-minority ethnic teams secured just 1.58% of available VC, and mixed ethnic teams a further 22.55%[52].

1.3.2 The productivity puzzle

The UK is thought to suffer from a 'productivity gap'. As part of this, and despite its world-leading research base, it too often fails to make the most of the innovation – leading to innovations failing to take off or moving overseas and benefitting other countries instead. The productivity gap is often referred to as a 'productivity puzzle' as it is not easily explained using current economic models – it is considered a Total Factor Productivity (TFP) puzzle. The aftermath of structural changes resulting from a shift from manufacturing-intensive to a service-oriented economy; and the wider economic downturn that affected all developed countries provide further contextual influences contributing to the TFP puzzle. PA's research suggests that there is strong evidence of the UK's strengths and weaknesses in some areas, and weaker (or no) evidence for other explanations of relative strengths and weaknesses:

52 Extend Ventures. (2020). Diversity Beyond Gender: The State of the Nation for Diverse Entrepreneurs. https://www.extend.vc/_files/ugd/52d2fc_1b4c9ee497fb437d99facdc7ed847083.pdf

Figure 6: Overview of UK strengths and weaknesses in IDA.

	Strong evidence	Some evidence	Weak evidence / anecdotal
UK Strengths	World-leading research base Adherence to rule of law, strong regulatory environment for health and safety Easy to set up new businesses, lots of small and medium-sized enterprises (SMEs) Good access to seed funding London as a global financial centre	Support from accelerators and incubators Catapults University Technology Transfer Offices (TTOs) Regional hubs/ place-based clusters for specific technologies	Strong ethical values Service-based economy puts us higher on the value chain High level of trust in UK institutions and rule of law British culture is particularly inventive
UK Weaknesses	Comparatively low levels of success in commercialisation Slow government procurement Relatively low use of patents Gaps in skilled workforce especially STEM Misaligned incentives, poor leadership Low risk appetite in UK businesses	Lower than average as % GDP investment in research Gap in funding for scale ups Lack of diversity and inclusion Too much bureaucracy Reliance on FDI Start-ups being bought and moving overseas	Lack of Government focus on purpose and solving challenges No common approach to measuring end to end impact Move from manufacturing to services has made us less innovative Lack of diversity among entrepreneurs

Source: PA

1.4 Is the UK innovation landscape effective at diffusion and adoption?

The UK's innovation landscape could be more effective to induce and facilitate greater IDA. There is a gap for support focused on scale-ups, business growth, marketing, and behavioural science factors influencing (either positively or negatively) IDA. There is some evidence that a more diverse, equal and inclusive ecosystem would enable better IDA.

1.4.1 The UK Innovation Strategy

The UK Government is strongly supportive of innovation. The UK's Innovation Strategy sets out a vision for the UK to be 'a global hub for innovation'[53]. It sets out four key pillars:

- Pillar 1: Unleashing business – we will fuel businesses who want to innovate
- Pillar 2: People – we will make the UK the most exciting place for innovation talent
- Pillar 3: Institutions and places – we will ensure our research, development and innovation institutions serve the needs of businesses and places across the UK
- Pillar 4: Missions and technologies – we will stimulate innovation to tackle major challenges faced by the UK and the world and drive capability in key technologies

Through these pillars, the strategy aims to both establish the right underlying policy environment and clearly signal those areas where Government will take the lead. The Innovation Strategy concludes: "The UK's research and innovation system has remarkable strengths across the country. There are globally significant innovative firms and thriving clusters of dynamic small and medium-sized firms in all parts of the UK. However, we still have too few strong innovation clusters. Too many places are not yet fulfilling their innovation potential, missing out on the good jobs and growth that a thriving local innovation economy can bring, and not enough places are seeing the economic benefits of innovations developed elsewhere through the adoption of those innovations. Addressing this challenge will be a central part of meeting the government's objectives for levelling up the UK economy: increasing research and innovation activity in more places, and supporting IDA, would have a major positive impact on the UK's overall economic performance and would create jobs, growth and productivity gains across the country."

53 UK Innovation Strategy: leading the future by creating it. (2021). Retrieved 1 April 2022, from https://www.gov.uk/government/publications/uk-innovation-strategy-leading-the-future-by-creating-it

1.4.2 Related Government priorities

IDA is also seen through the wider lens of delivering key Government goals such as the drive to net zero. It can also help deliver the 'Levelling Up' agenda, with the Strategy promising to "work with places to deliver local growth, tailoring our relationships to reflect differing levels of innovation maturity; high potential international R&D clusters of the future; areas with emerging R&D strengths; and those that currently have limited R&D capacity, but a lot to gain from greater IDA developed in other parts of the UK… We will also work with local places to develop proposals for a cross-government approach to supporting IDA amongst local businesses, in places with less developed Research and Innovation capacity."

The Integrated Review[54] sets out how science and technology can also create a strategic advantage for the UK. It states: "As competition grows between states, S&T will also increase in importance as an arena of systemic competition. In the years ahead, countries which establish a leading role in critical and emerging technologies will be at the forefront of global leadership…the UK must take an active approach to building and sustaining a durable competitive edge in S&T – anticipating, assessing, and acting on our S&T priorities to deliver strategic advantage for the UK. This will become increasingly important to our domestic prosperity and our international relationships in the coming decade. It is also an essential foundation for all the objectives in this Strategic Framework: ensuring that the UK has the tools and influence to shape a future international order based on democratic values; bolster our security and maintain military advantage; and contribute to building a more resilient world."

The Government has set out an R&D Roadmap setting out how the UK will become a 'Science Superpower'[55]. While this report focuses on R&D, it is an important contribution to identifying the levers relevant to diffusion and adoption that the Government could use to create the right underlying policy environment for IDA, pointing to areas where Government should take the lead, and where businesses, universities and the wider innovation ecosystem could do more. The survey conducted for the Roadmap identified several cross-cutting themes:

- **Long-term and sustainable funding**, with a diverse range of funding approaches to reach a wide range of organisations across the UK.

54 Global Britain in a Competitive Age: the Integrated Review of Security, Defence, Development and Foreign Policy. (2021). Retrieved 1 April 2022, from https://www.gov.uk/government/publications/global-britain-in-a-competitive-age-the-integrated-review-of-security-defence-development-and-foreign-policy/global-britain-in-a-competitive-age-the-integrated-review-of-security-defence-development-and-foreign-policy#sustaining-strategic-advantage-through-science-and-technology

55 UK Research and Development Roadmap. (2020). Retrieved 1 April 2022, from https://www.gov.uk/government/publications/uk-research-and-development-roadmap

- **Greater support for collaboration and knowledge exchange across the R&D landscape** – academia, industry, the public sector, the public, and across sectors, nationally and internationally.
- **A strategic and long-term approach** to set a clear direction for the UK, attract international talent, and coalesce businesses around common goals and global challenge.
- **An improved research and innovation culture,** proactively supporting and developing diversity at all levels across the sector.
- **Continued support for education, training, and skills**, with the ability to acquire new skills across all regions of the UK and ensure the demands of the future workforce are met.

1.4.3 Key actors in the innovation ecosystem

The UK has a highly fragmented, complex, and interdependent innovation ecosystem. The UK has more than 150 universities[56], and over 200 Research and Innovation Organisations (RIOs) (as distinct from universities), including Public Sector Research Establishments (PSREs). Anecdotal evidence suggests that most activities are focused primarily on R&D and innovation ideation, with less emphasis on commercialisation, diffusion or adoption of innovation. This ecosystem can be confusing to navigate and requires significant investment of time to engage with, both for innovators/academics and for the private sector/customers. Too often initiatives are created without sufficient consideration of what is already there and how to improve it, leading to new entities being added without sufficient thought and clarity of purpose/role, and often without sufficient funding to achieve their intended objectives. There is an opportunity cost to this, as job roles are created merely to interface with an ever-growing stakeholder network.

There are four main groups or 'sectors' playing different roles:

- **Public sector:** Government (including UKRI and Innovate UK which are key funding bodies), Public Sector Research Establishments, National Academies and Institutes, Research Councils, National Laboratories, universities and their Technology Transfer Offices, Catapults and accelerators, and public services including health, education, transport, and Local Government including Local Enterprise Partnerships.
- **Private sector:** large and small businesses, entrepreneurs, start-ups, financial services, and private equity investors (angel investors, venture capital), institutes, accelerators, and incubators.
- **Third sector:** charities, community and voluntary groups, co-operatives, local communities.

56 HESA. www.HESA.ac.uk

- **Consumer sector:** the organisations and individuals that buy and use innovation, and shape demand.

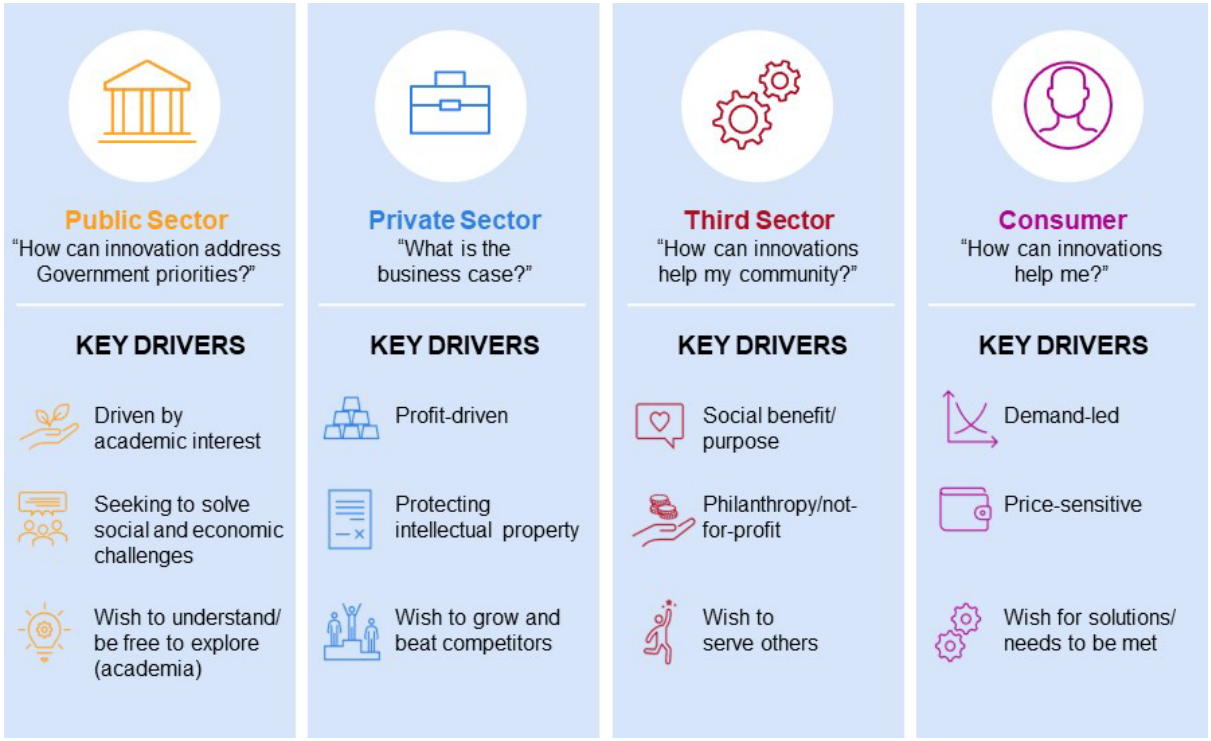
Figure 7: The UK's Innovation Ecosystem.

Source: PA. Note: ARIA is being set up, DIT is now DBT and BEIS is now DSIT for the purposes of this diagram

1.4.4 Innovation drivers by actor

Purpose and motivations can vary significantly between these groups, leading to barriers to IDA. Roles can also overlap, for example, both public and private sector organisations can be drivers and major consumers of innovation. Broadly, each sector has a different set of drivers which characterize their approach to innovation:

Figure 8: Drivers for innovation across innovation actors.



Source: PA.

While there is a commonly held view that private sector innovation is faster, more responsive, more risk-taking, and more efficient than in the public sector, and the public sector would benefit from following their example, this does not hold up to scrutiny[57] and there are many good examples of public sector innovation[58] [59]. However, the public sector does operate in a context where stability, cost/value ratios and consistency are more highly prized and risk appetites are lower[60]. Governments face more complex processes than businesses, with more stakeholders, and are accountable for spending public money, and these factors can make adoption of innovations within government and public sector organisations slower[61]. They can also face more public scrutiny, which can lead to risk aversion[62].

Universities play a key role in developing research and ideas: but often a lesser role in IDA. There are many productive and mutually beneficial partnerships between universities and private sector: either in the form of collaborative partnerships

57 Mazzucato, M. (2011). The Entrepreneurial State. London: Demos

58 Fuglsang, L., & Pedersen, J. S. (2011). How common is public sector innovation and how similar is it to private sector innovation?. In Innovation in the Public Sector (pp. 44-60). Palgrave Macmillan, London.

59 Koch and Hauknes (2005) 'On Innovation in the Public Sector'. Publin Report No. D20, NIFU STEP, Oslo.

60 Lynn, L. E. (1997). Innovation and the public interest: Insights from the private sector. Innovation in American government: Challenges, opportunities, and dilemmas, 83-103.

61 Kamal, M. M. (2006). IT innovation adoption in the government sector: identifying the critical success factors. Journal of Enterprise Information Management.

62 Andersen, S. C., & Jakobsen, M. L. (2018). Political pressure, conformity pressure, and performance information as drivers of public sector innovation adoption. International public management journal, 21(2), 213-242.

between academia and business[63] or academia and Government. However, risks arise with the 'fundamental trade-off' between creative research (academic freedoms under the Haldane Principle[64]) and focusing on political priorities or commercial interests: these trade-offs may hamper IDA as different parties operate under different incentives, interests, and motivations. Too often, academic culture doesn't encourage IDA because academics are incentivised and motivated to do primary research (which is what interests them) while being measured on publication citations (from 1 April 2022 all research must be open access, preventing publicly funded research being hidden behind paywalls). Instead, these activities need to be seen as being complementary, not competitive.

1.4.5 Innovation diffusion and adoption drivers by sector

Different parts of the ecosystem play different roles in different stages of IDA: but not all parts of the ecosystem have a role to play at all stages. Across this innovation ecosystem, the greater proportion of effort and resource lie at the earlier stages of innovation (relationships, networks, and ideation), fundamental research and science infrastructure, rather than focusing on pull-through and exploitation: arguably this is where the gap lies in which great ideas fail to become widely adopted. There is a broad shift from public sector R&D and enabling ecosystem, towards private sector production and consumer adoption, with key roles for regional/local places, and individual/ behavioural change. The greyed-out gaps suggest that in some areas a more joined-up approach may help plug some of the gaps in IDA. The ecosystem has all the elements needed, but it is too fragmented to effectively collaborate (both in terms of the number of stakeholders and the way these stakeholders are structured) which can cause duplication of effort, spreading resources too thinly and missed opportunities.

63 The Dowling Review of Business-University Research Collaborations. (2015). Retrieved 1 April 2022, from https://www.raeng.org.uk/publications/reports/the-dowling-review-of-business-university-research

64 Haldane, Lord. (1918) Report of the Machinery of Government Committee (Haldane Report). Ministry of Reconstruction, London, cmd. 9230

Figure 9: Stakeholders' roles in IDA.

Stakeholder Roles	Regulation	Funding	Skills	Support services	R&D	Producers	Early customers	Consumers
Government	Policy, law Scrutiny Priorities Challenges	Fund R&D Accelerators Loans	Education system, STEM	Accelerators				Buy products/ services
UKRI, Innovate UK		Fund R&D Accelerators Loans		Accelerators				
Research and Innovation Organisations			Expertise Career paths	Catapults	National Laboratories		Research Labs buy high-tech kit	
Universities and Further Education	Provide evidence base	Licensing, IP	Higher Education providers	Technology Transfer Offices	Research Knowledge Transfer			
Public sector – NHS, Military etc.		Fund R&D	Expertise Career paths	Accelerators	Knowledge Transfer			Buy products/ services
Start-Ups/ Scale Ups/ SMEs			Team building		Spin out companies	Develop new products/ services	Supply chain	Profit Supply chain
Private investors		Seed Fund VC Series A Bank loans						Profit
Large Businesses (UK and international)	Lobby groups	Fund R&D and product development	Expertise Career paths	Incubators/ accelerators	Partnerships with universities	Manufacture Marketing Brand	Routes to market Logistics Supply chain	Buy products/ services Profit Supply chain
Regional/ Local/ Third Sector			Training	Infrastructure	R&D Clusters Science Parks	Distribution Networks	Supply chain	Buy products/ services
Individuals/ Consumers			Upskilling Diversity Experience		Researchers	Entrepreneurs Employees	Early adopters Influencers Social media	Buy products/ services Behaviour change

Source: PA

1.4.6 The public sector's role in innovation diffusion and adoption

The public sector is highly diverse and touches many aspects of the ecosystem and innovation diffusion, and adoption process. For example, Government is a major source of funding for research. DSIT provides funding to UKRI, which includes Innovate UK and all seven Research Councils. Government also plays a role in providing and regulating public education to develop the skills the UK needs, through the DfE. The Government creates an enabling environment for IDA, through regulation, policy, guidance, setting priorities and challenges, and the funding and provision of innovation services such as Catapults and accelerators, including as the Defence and Security Accelerator (DASA). Innovate UK has also created three 'Catalyst' programmes (Agri-tech, Energy, and Industrial Biotechnology) which support early-stage feasibility studies, industrial stage research and provide

experimental development grants. Across the wider public sector, Research and Innovation Organisations (RIO) collaborate with other organisations such as universities to undertake fundamental research and development and engage in knowledge transfer activities. The public sector is also a consumer of innovative products and services.

However, as the greyed-out areas show, there are opportunities for Government and the wider public sector to do more to act as first/anchor customer, giving start-ups a much-needed cash boost, and to accelerate public procurement and alter commercial rules ensuring sustainable cash flows and multi-year contracts for innovative companies. While the Government has set an ambitious target to spend 33% of central Government procurement funding on SMEs by 2022, the overall use of SME suppliers (either direct or as part of a Tier 2 supply chain) has fallen since 2016 from 21% to 19%. There have been measures to improve payments, make it easier for SMEs to bid for Government contracts through the Digital Marketplace[65], the appointment of departmental SME champions to lead on supporting SMEs and departmental action plans, and excellent examples of increasing SME supply chains, for example by Network Rail[66]. The Ministry of Defence recently launched its second SME Action Plan[67] highlighting that in 2019/20, £1.1bn of its £21.1bn spend with industry was spent directly with SMEs and £3.4bn indirectly (21.3%). However, much of this is on small-scale experimentation and R&D rather than large contracts to supply at scale. Getting this right would entail a very different level of risk appetite on the part of Government, as investment in SMEs is hindered by concerns that buying from a start-up will mean they won't exist to supply/support in future.

65Crown Commercial Service SME Action Plan. (2021). Retrieved 1 April 2022, from https://www.gov.uk/government/publications/crown-commercial-service-sme-action-plan/crown-commercial-service-sme-action-plan--2

66 Information for SMEs - Network Rail. Retrieved 1 April 2022, from https://www.networkrail.co.uk/industry-and-commercial/supply-chain/information-for-smes/

67 Opportunity and Innovation: The Defence Small and Medium-sized Enterprise (SME) Action Plan. (2022). Retrieved 1 April 2022, from https://www.gov.uk/government/publications/opportunity-and-innovation-the-defence-small-and-medium-sized-enterprise-action-plan/opportunity-and-innovation-the-defence-small-and-medium-sized-enterprise-sme-action-plan

1.4.7 The private sector's role in innovation diffusion and adoption

The roles that the private sector (start-ups, scale ups, SMEs, private investors, and large businesses in the UK and international, plus legal firms, consultancies and other business-to-business support services) play is no less complicated. It includes working with universities to develop ideas for new products and services, taking an entrepreneurial approach to innovation, increasing production to become part of (often global) manufacturing and supply chains, and growing the business – including attracting and retaining the right skills mix. Private investors (banks, VCs, angel investors) and larger businesses in various sectors invest in developing innovative products and services: larger businesses also help to shape the enabling environment through lobbying; invest in growing expertise and developing careers; create innovation support services such as incubators and accelerators, bring new products and services to market (strategies, marketing, customer insights, branding); and are also themselves consumers of innovation – both internal innovation (for instance, new ways of working) and as buyers of products and services.

> **Survey Insight:** The global 'Innovation Matters' survey showed that 66% of innovation leaders are very good at understanding and anticipating customer needs.

Small new companies can find it easier to exploit new technology opportunities more quickly than larger businesses because smaller companies are more willing to take risks, hungry for customers and able to pivot quickly to customer needs[68]. Private sector innovators, both large and small, may have easier pathways to IDA, as the private sector operates from a clear purpose to out-innovate competitors – a common mantra is that businesses must 'innovate or die'. This clarity of purpose, combined with a simpler stakeholder landscape (fewer people who need to agree something before it can happen) and more of the levers being under the direct control of the company can make it easier for the private sector to navigate the barriers to diffusion and successfully adopt innovations. However, there are many examples of private sector failure too. A large, more bureaucratic process-heavy company with legacy technology in place may be unable to respond as quickly as an SME: the bigger company can also choose not to respond to new market signals because it is busy satisfying its existing customer base. SMEs may have first mover advantage: but sectors with larger numbers of SMEs may lack the capacity to diffuse and adopt innovations – whereas large businesses have the customers, reach, and heft to drive IDA. Large corporations in some sectors have been keen to work together with SMEs[69] and have moved towards open innovation models, seeking to create or tap into wider innovation ecosystems to discover new ideas, spot trends,

68 Christensen, Cm M. (2013). The Innovator's Dilemma: When New Technologies Cause Great Firms to Fall. (1st ed.). Harvard Business Review Press 45
69 Nieto, M. J., & Santamaría, L. (2010). Technological collaboration: Bridging the innovation gap between small and large firms. Journal of small business management, 48(1), 44-69.

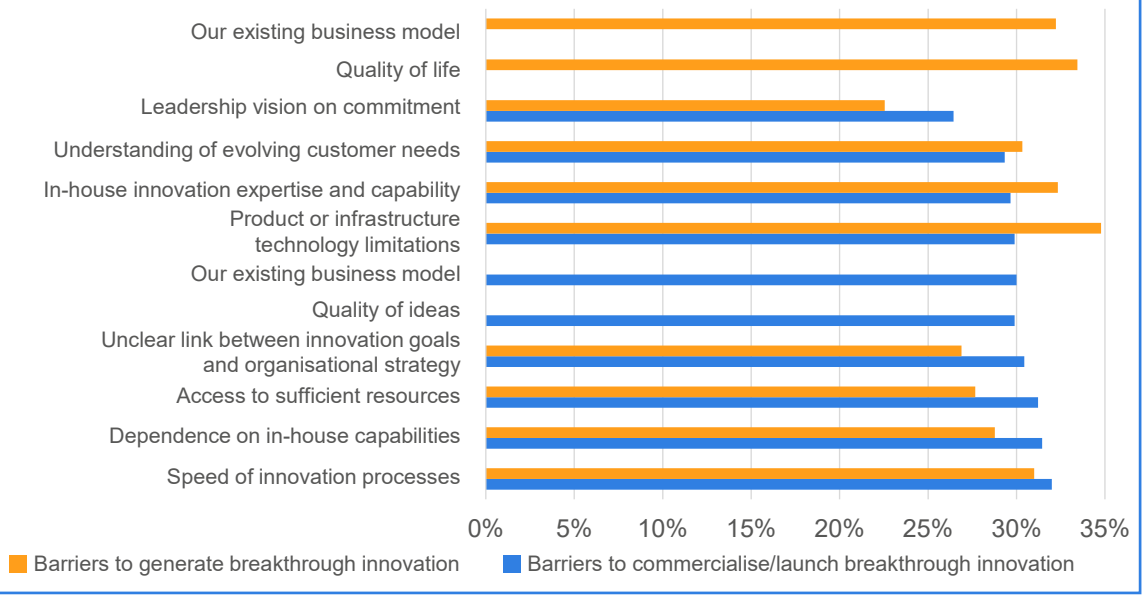
and benefit from ‘first mover’ strategic advantage. This model of tapping into SMEs and the wider innovation ecosystem is one that Government and the public sector could explore through further research to understand if it would be a suitable approach to emulate.

Innovation Matters Survey: Key Findings

Over 800 senior executives globally

- 82% of respondents say their performance management rewards uniformity over creativity.
- 54% of organisations are rejecting the very disruptive ideas that may lead to their greatest success.
- 54% of successful innovators consider the ability to kill projects at core strength, compared with only 40% of their less successful peers.
- 50% executives don’t believe their leaders show the vision and passion needed to make innovation happen.
- 24% are fully confident they have defined the skills and activities needed to be innovative.
- 41% often take part in formal horizon scanning and scenario planning compared to just 25% of their less successful peers.

Barriers to generate and commercialise breakthrough innovation



1.4.8 Public-private collaboration

The main model for innovation in the UK is the transfer of knowledge between universities/national laboratories/research institutes and the private sectors[70] [71] on the assumption that 'knowledge spill over' will occur from the strong research base, and that this can be improved by forging strong links between industry and academia[72]. Innovation support services such as Technology Transfer Offices (TTO), the nine thematic Catapults (Cell and Gene Therapy, Connected Places, Compound Semiconductor Applications, Digital, Energy Systems, High Value Manufacturing, Medicines Discovery, Offshore Renewable Energy, Satellite Applications), and various accelerators have been created to facilitate this knowledge transfer. However, knowledge transfer doesn't always work. While many universities now have Technology Transfer Offices[73] leading to some spin-out companies, this has not led to the expected benefits in IDA, with only 1.1% of published patent applications in 1999-2018 coming from UK Higher Education Institutes[74]. Overall patent registrations have been broadly static in the UK (with continuing strong performance in civil engineering, computer technology, and transport), but there has been an increase in trademarks and design applications[75]. Research in the UK and in other regions show there are questions over the efficiency, scale and lack of skills and experience[76] of TTOs[77] leading to some academics avoiding them[78] and in some cases universities failing to resource and support their own capabilities[79]. Very few TTOs are sustainable (covering their own costs) – let alone profit-generating – and many prioritise revenue (their main metric) over innovation success[80].

The third sector, comprising of charities, community groups, Nesta and co-operatives, may also fund R&D, for example in healthcare. They also play a key role in lobbying for regulations or policy changes, creating more opportunity for a

70 Bessant, J. (2005). Enabling continuous and discontinuous innovation: Learning from the private sector. Public Money and Management, 25(1), 35-42.

71 Aghion, P., Dewatripont, M., & Stein, J. C. (2008). Academic freedom, private-sector focus, and the process of innovation. The RAND Journal of Economics, 39(3), 617-635.

72 Acs, Z. J., Audretsch, D. B., & Lehmann, E. E. (2013). The knowledge spill over theory of entrepreneurship. Small business economics, 41(4), 757-774.

73 Siegel, D. S., Veugelers, R., & Wright, M. (2007). Technology transfer offices and commercialization of university intellectual property: performance and policy implications. Oxford review of economic policy, 23(4), 640-660.

74 Intellectual Property Office (2020), IP filing habits of UK Higher Education Institutions https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/887908/ip-filings-habits-of-uk-higher-education-institutions.pdf

75 Facts and figures: patent, trade mark, design and hearing data: 2020. (2021). Retrieved 1 April 2022, from https://www.gov.uk/government/statistics/facts-and-figures-patents-trade-marks-and-designs-data-2020/facts-and-figures-patent-trade-mark-design-and-hearing-data-2020

76 RSM PACEC LTD. (2018). A report for the department for business, energy, and industrial strategy [Ebook].

77 Chapple, W., Lockett, A., Siegel, D., & Wright, M. (2005). Assessing the relative performance of UK university technology transfer offices: parametric and non-parametric evidence. Research Policy, 34(3), 369-384.

78 Hamilton, C and Schuman, D () Love and Hate in University Technology Transfer: Examining Faculty and Staff Conflicts and Ethical Issues. https://files.eric.ed.gov/fulltext/ED577446.pdf

79 Ustundag, A., Uğurlu, S., & Kilinc, M. S. (2011). Evaluating the performance of technology transfer offices. Journal of Enterprise Information Management.

80 The UK's innovation ecosystem. Wellcome Trust.

product/service to reach the end user. Consumers and adopters across all sectors play a vital role in shaping demand.

1.4.9 Regional and local innovation diffusion and adoption

The roles of regional and local organisations in IDA vary across the UK. Central and local government can play a key role in place-based innovation – noting that place-based policies are highly dependent on the political, social, and economic context[81]. This can range from creating spaces where businesses can co-locate, increasing cross-fertilisation of ideas, through to shaping and incentivising specific types of technological or social entrepreneurship[82]. Visualising regional and local infrastructure as part of a national supply chain, rather than an eco-system, may help places and regions find their core purpose and USP, building on their existing strengths – for example in coastal energy, wind power, medtech, or agri-tech. The right balance needs to be struck between local, regional and national innovation efforts, where IDA is rooted in local and regional organisations, structures, funding and resources. Having the right local and regional infrastructures in place is therefore key to facilitating IDA. Regional effects seem to be particularly important at the earlier stages of diffusion[83], but as barriers to innovation diffusion are reduced by social media and digital technologies, there is some evidence that geographical proximity has become less important in innovation diffusion[84].

Local authorities, Local Enterprise Partnerships (LEPs), Catapults, and other regional sectoral organisations (public and private) can be a source of expertise and training, create the on-the-ground infrastructure (physical and virtual) that innovations need to be diffused/adopted, and can thematically ‘cluster’ groups of SMEs, support services, private sector and universities in ways which can amplify their impact. The UK’s Catapults play an important role as a regional network that deliver both direct and indirect benefits to their areas[85]. LEPs have been set up in 38 regions of the United Kingdom, each dedicated to meeting different market needs: for example, the South-East Ashford Local Enterprise Partnership focuses on international rail connectivity.

81 Morisson, A., & Doussineau, M. (2019). Regional innovation governance and place-based policies: design, implementation and implications. Regional Studies, Regional Science, 6(1), 101-116.

82 Elmes, M. B., Jiusto, S., Whiteman, G., Hersh, R., & Guthey, G. T. (2012). Teaching social entrepreneurship and innovation from the perspective of place and place making. Academy of Management Learning & Education, 11(4), 533-554.

83 Baptista, R. (2000). Do innovations diffuse faster within geographical clusters? International Journal of industrial organization, 18(3), 515-535.

84 Mallinson, D. J. (2021). Who are your neighbours? The role of ideology and decline of geographic proximity in the diffusion of policy innovations. Policy Studies Journal, 49(1), 67-88.

85 Catapult Network Review How the UK’s Catapults can strengthen research and development capacity. (2021). Department For Business, Energy & Industrial Strategy.

Source: Cambridge University – Lucy Sharman.

Example of successful innovation cluster: Cambridge and Peterborough

The Cambridge environs have been an innovation phenomenon since the 1960s, producing over 20 ‘unicorn’ companies. The presence of Cambridge University has been key, as has a long-standing focus on technology transfer activities and entrepreneurship among academics, which have been well supported by the University. The area has attracted many new start ups and businesses to locate in the area, focusing on the life sciences, IT, agritech and advanced manufacturing industries in particular. The ecosystem currently employs 61,000 people and consists of over 5,000 knowledge-intensive firms, with a combined annual revenue £15.5bn. The area has benefited from:

- Strong skills and high levels of education and prosperity
- Good transport links to London and internationally
- Good connectivity and services
- High quality of life

However, there are constraints in infrastructure, some skills shortages, and high housing costs which may limit growth.

Regional diffusion of innovation is likely to depend on factors of geographical proximity, a critical mass of skills and jobs that attract people to live and work there, and other factors such as appeal, cost of living, ease of access and local funding sources. Uptake of innovation can be geographically uneven, favouring urban places with a high concentration of services, more diversity of industries and ready access to workforce) plus more people in direct communication (more human capital) and lower barriers to meeting up through better transport links. Wealthier areas may also have more people with disposable capital who may be more likely early adopters of new technologies[86]. Location can be an important component of technology adoption – and the impact of a diverse region on adoption is even greater for small enterprises than for large ones[87].

In the UK, these effects can be seen in clusters around science parks and universities, where the R&D infrastructure ties together a web of local businesses, universities, and public bodies[88]. Some areas become renowned for their products, or for specific technologies or technology families,[89] which become successful thanks to strong social relationships, a critical mass of skills and workforce, improved communication, and a shared sense of purpose. These clusters mean that IDA is not evenly spread across the UK[90]: there are hotspots in London, Cambridge, Manchester, Oxford, Edinburgh, Bristol, Leeds, Birmingham, Newcastle, Cardiff, and Belfast. Cambridge is the leading regional tech city in the UK thanks to its combination of high levels of VC funding, venture capital rounds, advertised tech salaries, number of unicorns (tech companies worth more than $1bn) and ‘futurecorns’. The challenges faced by each sub-region are different and highlight the importance of local authority and policy that can channel national government resources to address regional requirements more directly. There is a need to support innovation clusters, and for policy that can better diffuse their benefits and address barriers to IDA in regions surrounding them.

86 Antonelli, C. (1990). Induced adoption and externalities in the regional diffusion of information technology. Regional Studies, 24(1), 31-40.

87 Kelley, M. R., & Helper, S. (1999). Firm size and capabilities, regional agglomeration, and the adoption of new technology. Economics of Innovation and New technology, 8(1-2), 79-103.

88 Minguillo, D., & Thelwall, M. (2012, June). Mapping the network structure of science parks: An exploratory study of cross-sectoral interactions reflected on the web. In Aslib Proceedings. Emerald Group Publishing Limited.

89 Lasuén, J. R. (1973). Urbanisation and development—the temporal interaction between geographical and sectoral clusters. Urban studies, 10(2), 163-188.

90 Marshall, A., Shaw, G., Murphy, D., Sena, V., Rosiello, A., Carr, C., ... & Hickman, S. (2020, June). Knowledge absorption and innovation in UK SMEs: A pilot study by place and economic sector. In Proceedings of the 2020 International University-Industry Interaction Conference. UIIN.

Example of best practice in Further Education: engaging colleges and business to upskill and meet industry needs locally

Further Education works on the interface between colleges and businesses to improve IDA, by upskilling and meeting industry needs locally and, for some sectors, nationally. Local Skills Improvement Plans have been launched, bringing employers, colleges and other education providers, and local stakeholders together to set out the key changes needed to make technical skills training more responsive to employers' skills needs. The plans were piloted in 2020-21 and have been rolled out nationally in 2021-22; by 2022-23 all regions in England should have an LSIP in place.

The Department of Education has also launched the Strategic Development Fund, providing colleges and other education providers capital and revenue funding to invest in developing and delivering new skills provision, and associated equipment and facilities, that directly meet the needs of employers, based on existing local plans. The fund was piloted in 18 regions across England in 2020-21 and has been rolled out nationally in 2021-22.

Looking at a case study funded by the SDF, 24 colleges across eight areas have upgraded their curriculum to support training related to the servicing and maintenance of electric and hybrid vehicles. This upgrade means including training rigs, charging points and demonstrator vehicles in automotive workshops provided by the colleges.

More can be done to join up the bottom-up Local Skills Improvement Plan with a top-down 'National Skills Improvement Plan' that provides a role for all players in the skill supply chain to upskill the United Kingdom.

There are three alignments that need to be made to improve IDA based on existing FE activity. The first is support for businesses, especially SMEs, to identify available and relevant innovations so they are aware of their innovation gaps. This would help employers identify their future skills needs that would then inform LSIPs and conversations employers have with skills and training providers. The Skills Value Chain provides a response to this challenge, seeking to embed innovative skills in the workforce to enable the adoption of innovation. The Skills Value Chain comprises three steps: convening centres of innovation, employers, and providers to undertake foresighting to identify emerging and future skills needs, developing courses and training to meets those needs, and delivering the courses and training to learners to meet employer needs. The Skills Value Chain is currently being piloted by the

Department for Education in the Emerging Skills Programme and an evaluation for the efficacy of the approach will be available from Spring 2022.

The second is the alignment of needs identified locally and nationally through the Local Skills Improvement Plan, the UK Industrial Strategy, and innovation centres such as Catapults.

The third is the alignment of activity across all players in the skills ecosystem, namely Further Education, Universities, Research Hubs, and training within industry. Making these alignments will ensure that funding is consistent, and that UK Government ambitions are being met both regionally and nationally through a supply chain of upskilling in the UK.

1.4.10 Sectoral innovation diffusion and adoption

UK businesses can lag in the adoption of new technologies: a 2020 survey of 1,000 UK businesses found that one-third had no plans to invest in data-driven technologies[91]. There is a gap in the knowledge and skills needed to understand the value of innovations and successfully integrate them. IDA in industry sectors is influenced by behavioural, economic, social, and technological drivers – and can play out very differently. The spread of agri-tech in farming is heavily influenced by local networks and neighbouring farmers, who are a trusted source of information and de-risk new technology. Healthcare innovation has received a boost from the COVID-19 pandemic, which has accelerated moves to online services, but significant barriers remain around spreading innovation between fragmented organisations. Manufacturing can be slow to adopt innovations and risk averse. There are also cross-sector barriers in common, such as funding constraints, and access to knowledge and skills – even in the technology sector, which has a deficit in STEM and cybersecurity professionals[92].

91 BT Business, Karonis F., (2020). The Future in 2020: The definitive review of how UK businesses are working with emerging technology https://business.bt.com/content/dam/bt/business/v2/PDF/campaigns/BT_The_Future_In_2020.pdf

92 Digital Leadership Report 2021. (2021). Harvey Nash Group. Retrieved from http://Digital Leadership Report 2021

PA's Innovation Survey of 751 senior business and government executives spanning 15 countries and nine sectors, showed that 47% of senior executives described their innovation activity as a 'costly failure'. Top barriers were 'fear' and 'lack of focus'. Key findings from each sector include:

In Defence, 47% of companies say poor communication is the biggest 'innovation killer'

Across the Public Sector, 51% said they talk about innovation more than they do innovation

83% of respondents in Life Sciences said innovation is core to their culture and mission

40% of people in Healthcare said overzealous risk management is their biggest problem in innovating

63% of those in Energy and Utilities have seen a brilliant idea fail for avoidable reasons

In Financial Services, 68% get more value from incremental innovation than breakthroughs

Sector Focus: Agri-tech

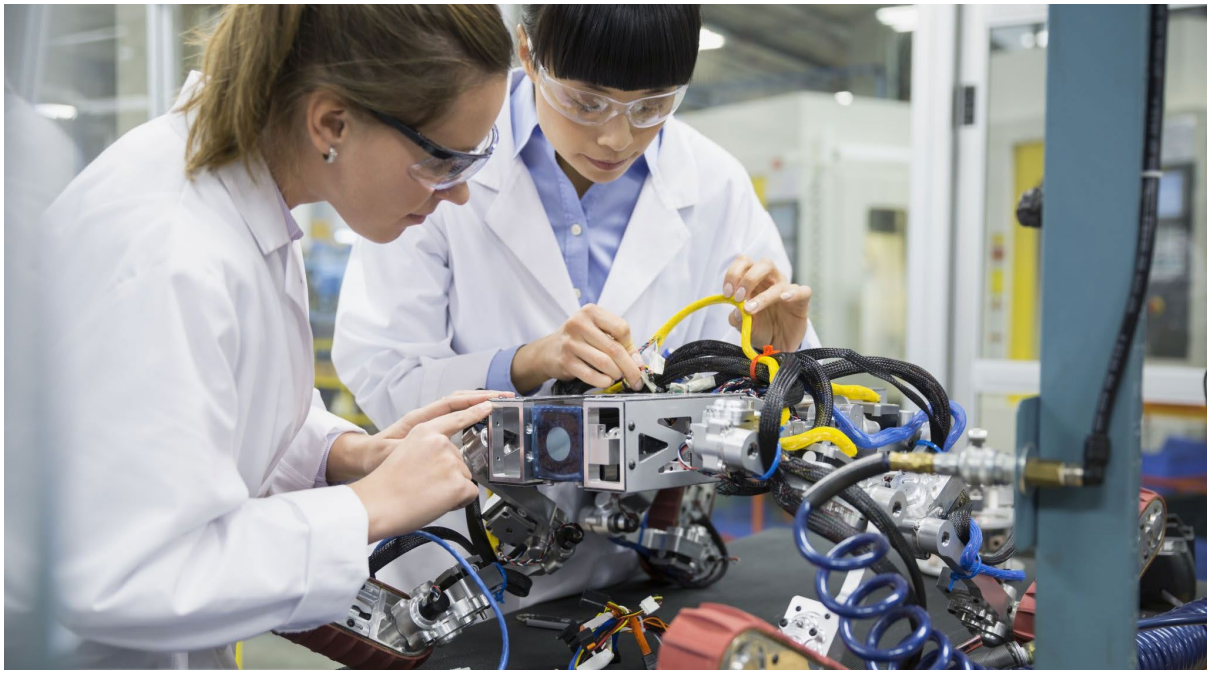
The UK is fast becoming a leader in agri-tech development, with agri-tech a key focus for the Cambridge cluster and Lincolnshire's agri-tech ecosystem attracting investment from large robotics firms. The area has evolved to become an innovation cluster, with close working between the University of Lincoln, farmers, start-ups, and larger tech investors.

- 78% of British farmers are using some form of agri-tech, with adoption rates being highest for younger farmers and large farms.
- Only half rated their agri-tech skills as "good" and only 43% felt supported in introduction and adoption of new technologies.
- Lack of knowledge is a key barrier, from trusted sources (such as other farmers).
- There is a need for accessible local training, independent advice, and access to funding.

Sector Focus: Healthcare

The UK has unique strengths in healthcare thanks to the NHS and strong industry links. The UK is world-leading in life sciences research. The NHS has benefitted from novel drugs and treatments, digitisation of admin services, connected devices for patient monitoring and new ways of collaborative working. Healthcare benefits from a strong shared purpose and aligned aims, which have galvanised during the COVID-19 pandemic. However, there are barriers that can limit diffusion and adoption, including:

- A highly complex and fragmented landscape.
- Organisational changes and lack of prioritisation, local leaders' attitudes.
- Lack of funding, and the need for 'boots on the ground' in order to get adoption happening.



Sector Focus: Manufacturing

Manufacturing plays a key role in scaling up innovations and bringing new products to market. Manufacturing companies are often small and medium enterprises (SMEs), which can be slow to adopt innovations and could do more to adopt existing technologies. More than half of manufacturing SMEs said that they would not invest in innovative technology. The biggest barriers to adoption for SMEs were:

- Insufficient capital to take the risk.
- Needing more knowledge and guidance.
- Confusing support platforms and advice.
- Lack of access to innovative technologies.

Programmes such as the Made Smarter initiative, targeting manufacturing SMEs in the North West, are helping SMEs apply for funding and providing expertise and advice on adoption of technology.

1.5 How does the UK compare internationally?

The UK is a global leader in innovation but compares less well in factors relating to IDA: specifically, in the conversion of R&D to revenue and outputs; human capital (workforce knowledge and skills); and the adoption of new technologies by UK businesses. Lessons from other countries suggest that having a systematic, government-led approach to innovation can facilitate IDA, with a focus on close research-government-private industry collaboration and dedicated scale-up support.

1.5.1 Measuring innovation diffusion and adoption

While there is no single or universal measure explicitly on IDA, we have drawn from the Global Innovation Index (GII), Global Competitiveness Index (GCI), and OECD labour productivity measure to compare the UK with several other countries globally. The GII is a leading measure to compare countries against a wide range of sub-measures. PA has selected those most relevant to IDA:

- **Business sophistication** – includes measures on proportion of the population in knowledge-intensive employment and the number of women employed with advanced degrees.
- **Knowledge diffusion and absorption** – includes measures on the proportion of IP payments, hi-tech and ICT exports/imports in total trade, FDI net inflows and outflows.
- **Innovation linkages** – relates to university and industry research collaboration, the state of cluster development, joint venture and strategic alliances, and patent families.

The GCI also ranks countries on multiple factors and includes measures relating to IDA, such as:

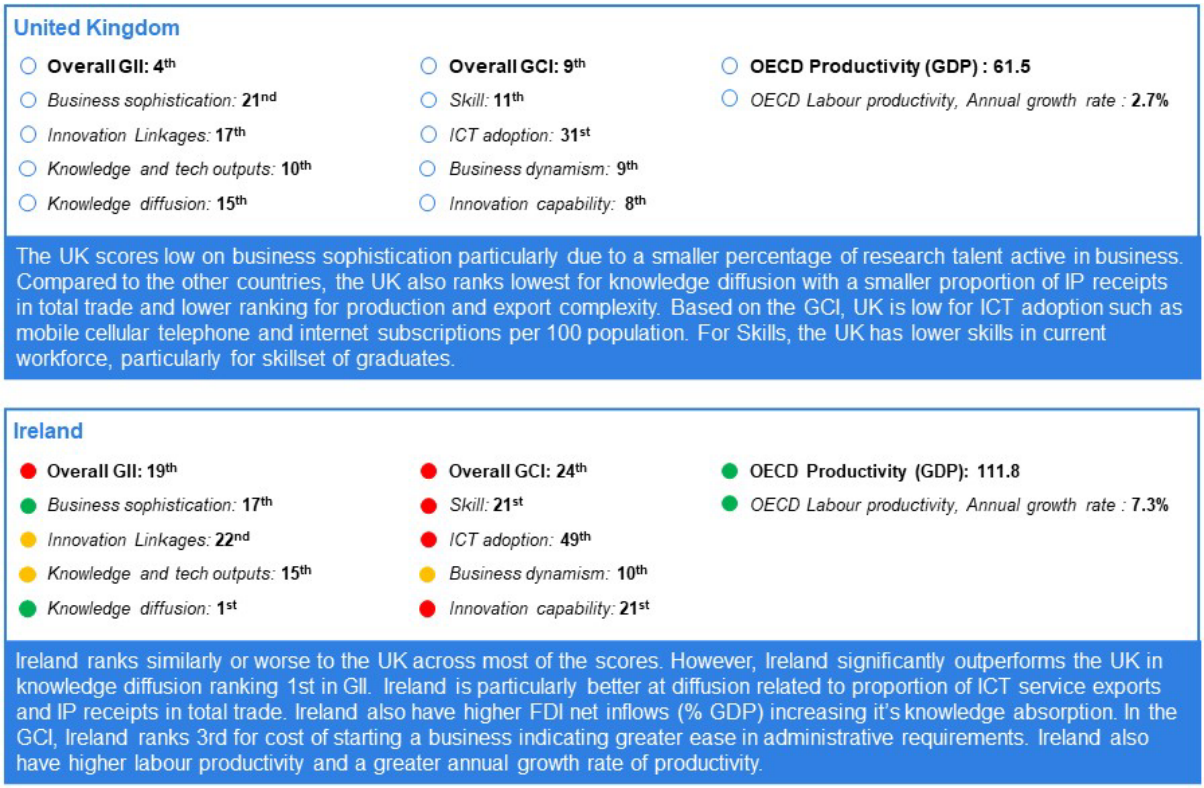
- **Skill** – includes measures on the current workforce, such as mean years of schooling, extent of staff training, quality of vocational training and skillset of graduates, and workforce digital literacy.
- **ICT adoption** – includes measures on the proportion of mobile cellular telephone subscriptions, and fibre internet subscription internet users in the population.
- **Innovation capability** – includes measures on the diversity of workforce, the state of cluster development, stakeholder collaboration, R&D expenditure, and commercialisation including trademark application per population.
- **Business dynamism** – includes measures on administrative requirements, such as cost and time to start a business, entrepreneurial culture, and attitude towards risk.

Finally, the OECD labour productivity measure provides insight on overall economic performance and labour productivity, which is a measure of how well innovation translates into productivity and higher living standards. The UK is ranked highly overall in both the GII (4th) and GCI (9th) but less well on OECD productivity. Despite the overall high performance of the UK in the other two indexes, this is largely thanks to its R&D and start-up ecosystem: the UK performs less well compared to other countries on the factors relating to IDA.

1.5.2 International case studies

PA has selected some comparator countries that demonstrate alternative approaches to IDA. For example, Finland, Japan, and South Korea demonstrate better knowledge absorption through research talent in business and higher skilled talent in general, whereas Ireland and Israel perform best in knowledge diffusion through a higher proportion of hi-tech and ICT exports. The RAG rating indicates whether a country performs better (green), similar to (amber), or worse (red) than the UK's baseline (white) against the overall survey, and specific sub-measures.

Figure 10: International comparators. Overall rankings and sub-measures are taken from the Global Innovation Index 2021 (GII), Global Competitiveness Index 2019 (GCI) and OECD Labour Productivity 2020-21.



Japan

- Overall GII Ranking: 13th
- *Business sophistication:* 10th
- *Innovation Linkages:* 18th
- *Knowledge and tech outputs:* 11th
- *Knowledge diffusion:* 11th
- Overall GCI: 6th
- *Skill:* 28th
- *ICT adoption:* 6th
- *Business dynamism:* 17th
- *Innovation capability:* 7th
- OECD Productivity (GDP): 48
- *OECD Labour productivity, Annual growth rate :* 1.2%

Japan has strong business sophistication attributed to knowledge absorption (ranking 3rd) due to a high proportion of research talent in business. Japan also have a higher proportion of IP receipts in total trade and also rank 1st for production and export complexity (particularly for high-tech exports) compared to the UK. Based on GCI, Japan have a higher patent application (per million population) compared to the UK.

Finland

- Overall GII: 7th
- *Business sophistication:* 6th
- *Innovation Linkages:* 3rd
- *Knowledge and tech outputs:* 5th
- *Knowledge diffusion:* 3rd
- Overall GCI: 11th
- *Skill:* 2nd
- *ICT adoption:* 13th
- *Business dynamism:* 7th
- *Innovation capability:* 12th
- OECD Productivity (GDP): 61.5
- *OECD Labour productivity, Annual growth rate :* 0.1%

Finland ranks significantly better than the UK in business sophistication and dynamism, due to a higher proportion of females employed with advanced degrees, high skill of current workforce and higher proportion of digital skill among active population. They have strong innovation linkages and strong university-industry R&D collaboration compared to the UK. Finland also rank highly for knowledge diffusion relating to ICT service exports and high proportion of IP receipts in total trade (ranking 1st in GII).

Korea

- Overall GII: 5th
- *Business sophistication:* 7th
- *Innovation Linkages:* 15th
- *Knowledge and tech outputs:* 8th
- *Knowledge diffusion:* 7th
- Overall GCI: 13th
- *Skill:* 27th
- *ICT adoption:* 1st
- *Business dynamism:* 25th
- *Innovation capability:* 6th
- OECD Productivity (GDP): 41.8
- *OECD Labour productivity, Annual growth rate :* 3%

Compared to the UK, Korea have a higher number of knowledge workers and a higher proportion of research talent in business (ranking 1st globally in the GII). Their business sophistication is driven by their strength in patent families. Korea are particularly strong in knowledge diffusion with high proportion of high tech exports in total trade. Korea ranks 1st for ICT adoption for fibre internet subscriptions (per 100 pop.), indicating a greater level of digital literacy in their population.

Israel

- Overall GII Ranking: 15th
- *Business sophistication:* 8th
- *Innovation Linkages:* 1st
- *Knowledge and tech outputs:* 6th
- *Knowledge diffusion:* 2nd
- Overall GCI: 20th
- *Skill:* 14th
- *ICT adoption:* 45th
- *Business dynamism:* 4th
- *Innovation capability:* 15th
- OECD Productivity (GDP): 45.9
- *OECD Labour productivity, Annual growth rate :* 6.2%

The UK rank better than Israel in overall global measures, Israel score significantly higher on sub-measures relevant for adoption and diffusion such as strong innovation linkages between industry and R&D, depth of cluster development and strong joint ventures and strategic alliances. Israel rank 2nd globally for knowledge diffusion particularly in high tech and ICT services exports. On the GCI, Israel score higher on their business dynamism relating to attitudes towards entrepreneurial risk, growth of innovative companies and companies which embrace disruptive ideas.

○ Baseline (UK) ● Performs better than the UK ● Performs same/ similar to the UK ● Performs worse than the UK

Source: PA.

The UK has much to learn from some of its global competitors, which have built on their unique strengths and taken a more holistic end-to-end view of innovation processes. The five case studies below (Finland, Ireland, Israel, Japan and Korea) demonstrate different approaches to diffusion and adoption which has translated into either economic, societal or environmental success. A further deep dive is provided on Korea and Israel as well researched examples.

Case Study: South Korea

Creating a distinctive global brand

South Korea has cemented its brand as a global cultural influencer with the popularity of K-beauty, K-pop and K-dramas evident. This cultural phenomenon is known as Hallyu or the Korean wave. It is the result of the Asian financial crisis limiting cultural imports from Japan as well as government focus on exporting popular culture, with reduction of censorship and £113 million funding for the Basic Law for Cultural Industry Promotion in the late 1990s.

What began with the success of K-drama Winter Sonata and diffusion of K-dramas within south-east Asia, has since expanded to secure Korean influence on music, popular culture, fashion, beauty and food across the globe. Adoption of Korean media can be seen through the Oscar win for Parasite, the popularity of Netflix drama Squid Game and success of K-pop band BTS in the UK charts.

Case Study: Israel

From start-up to scale-up

Israel has the highest density of start-ups per capita in the world. In recent years, the success of Israeli companies in attracting later stage funding has meant that Israel has moved from being a start-up nation to a ‘scale-up nation’. To date Israel has produced over 71 unicorns globally of which 29 unicorns still remain headquartered in Israel.

Israel’s ability to scale up innovation is the result of generous public provision of early funding, bridging the gap between R&D and the consumer market. For example, the success story of JFrog a platform that automates software releases and updates, launched in Israel with seed funding from the office of Israel’s Chief Scientist and a Series A from Gemini Israel Ventures (£2.8 million). With early funding, JFrog was able to continue its success with clients including Apple and Netflix and has a market valuation of more than £3.2 billion.

In addition to financial investment, Israel’s consistent investment in skills has allowed it to develop talent with an entrepreneurial mindset and technical strength. Several higher education institutions in Israel focus heavily on innovation and technology, exposing students to VCs, entrepreneurs and business leaders. The Zell Entrepreneurship programme over 20 years has produced 138 companies, of which 84 are active, and 22 have been sold or merged, raising over £9.5 million.

Case Study: Ireland

Attracting interest and funding to support diffusion and adoption

Ireland have used innovation to maintain competitiveness in global markets, provide jobs and sustainable growth in their economy. Ireland is currently the 10th most innovative country in the world, a significant jump from 21st place a decade prior. Through attracting the interest of European funding, Ireland has successfully converted innovation into globally adopted and diffused products and processes.

The Irish Government has focused closely on its strengths, driving Ireland's R&D presence forward in MedTech, pharma, and technology. The Government have allocated close to £800 million to R&D activities in 2020 into these sectors. As well as its own investment, Ireland increased success in competing for European Research Council (ERC) grants under Horizon 2020 (approx. £16 million). The ERC's prestigious grants support frontier research across all fields, on the basis of scientific excellence. Such funding may suggest greater interest from Europe and further dissemination of research, creating greater opportunities for research to be converted into innovation to be successfully diffused and adopted. In addition, Ireland maintains a 25% tax credit on expenditure incurred on qualifying R&D activities undertaken by companies in Ireland that are subject to corporation tax.

By ensuring financial incentivisation for research and a focus on funding to attract global eyes and interest, Ireland set themselves apart from UK in diffusion of knowledge and innovation.

Case Study: Finland

Creating sustainable urban development through open ecosystems

Finland is world leading for its ability to create high quality operating environments for enterprises and innovation. With the goal of facilitating sustainable urban development in Finland's six largest cities the "6aika" (The Six City Strategy) has funded a range of innovative projects across the country. By focusing on the largest cities, home to 30% of Finland's population, arguably the 6aika programme facilitates greater innovation diffusion and adoption through strengthening 'openness and accessibility'. The strategy achieves this through 3 focus areas to create intense collaboration between universities and industry.

1. Open innovation platforms (OIP): are functional structures in which the city community works together to create new solutions and new businesses, combining places, productised processes and people into an activity that creates value. With the Six City Strategy, cities facilitate the creation and testing of new products and services in real-world urban environments and innovation platforms, making use of new kinds of procurement processes

2. Open data and interfaces: Cities produce vast amounts of valuable data i.e., geographical, environmental, traffic, financial, etc., which companies can utilise in their business. As part of the Six City Strategy, cities open their data stores, making them compatible with and publishing them through shared publication channels as open data.

3. Open participation and 'customership': The Six City Strategy facilitates the creation of new business through the development of open and easy-to-use multi-channel and multi-operator service models and systems, in collaboration with customers.

Case Study: Japan

Ageing populations and innovation

National innovation policies, adopted by many countries initially directed investment into R&D and boosted industry. While these have allowed countries like Japan to rapidly grow their economies and commercialise technologies – these advances have presented societal and environmental consequences.

Japan's Realising Society 5.0 laid out an ambition to bridge government, business and academia and leverage cutting edge innovations (such as AI), to resolve social challenges such as such as the declining birth rate, an aging population, and environmental and energy issues.

This ambition is supported by policy responses such as a commitment to increase R&D spend to 4% of GDP by 2020, renewed guidelines for sharing of big data to encourage companies and continued funding of the Public Private R&D Investment Strategic Expansion Program (PRISM). In addition to this, there is a focus on fostering collaboration through cross-ministerial cooperation, risky innovation support through the Moonshot programme and university reform.

The ambition outlined by Realising Society 5.0 points to the importance of collaboration and integrating products and services, some of which are yet to be invented, around a shared purpose such as solving societal challenges. Many of the challenges faced by the aging population in Japan are likely to be reflected across other nations in the near future, as life expectancy increases. This pivot in policy highlights where innovation must make more than an economic case and will need to address the triple bottom line (social, environmental, and financial).

1.5.2.1 Deep dive 1: Korea

Key lessons for the UK from South Korea:

A systematic, government-led approach to innovation with a strong cultural brand can facilitate IDA

Focus on collaboration with a strong place-based element, building on traditional industries while welcoming hi-tech

Scale-up support should be inclusive of microenterprises.

Policy, regulation and taxes can create unreasonable burdens for SMEs and scale-up support should include support and reform in these areas.

South Korea is currently rated first for innovation in Bloomberg's innovation index and has joined the top 5 of the Global Innovation Index for the first time, thanks to a systematic government approach to innovation, close collaboration, and an intensive focus on R&D. Microenterprises and SMEs make up 99.99% of Korea's private industry.

The South Korean government has taken a top-down approach to innovation, with systematic reforms including an R&D focus and protectionist policies in the 1960s that allowed chaebols (industry clusters, often family owned) to grow from traditional industries such as textiles. Since the late 1990s, the government has worked with chaebols to create regional innovation centres, setting up the foundations for close industry-research collaboration and allowing large industrial clusters to pivot towards knowledge-intensive products and services which was vital following the 1997 Asian Financial Crisis. In the 2010s, SMEs in biotechnology, AI and cybersecurity emerged and were funded and supported by the government and the existing national technology infrastructure. This allowed companies such as Woowa Brothers, a 2010 start-up, to reach unicorn status by 2018. In addition to nurturing industry, government policies have systematically addressed barriers to diffusion, rolling out internet infrastructure, reducing censorship of previously controversial topics in media and policies to shift focus from large industry corporations to supporting SMEs.

The government has a history of close collaboration with both industry and research, through direct funding of R&D but also policies that directed chaebols to invest in R&D and creating innovation hubs. Korea invests heavily in R&D policy starting with the first Five-Year Economic Development Plan and later establishment of regional innovation centres such as Gyeonggi and is second only to Israel in gross domestic spend on R&D as a percentage of GDP[93]. This R&D focus has created a nation with

93 OECD (2022), "Gross domestic spending on R&D" (indicator), https://doi.org/10.1787/d8b068b4-en (accessed on 13 March 2022

one of the highest global concentrations of researchers, and significant IP activity with Korea ranking 4th in the world for patents filed[94]. Unlike in the UK, most of the R&D spend in 2019 (80%) was funded by private companies rather than direct government spending[95].

South Korea has a Ministry of SMEs and Start-ups (MSS) with a strong emphasis on entrepreneurship[96]. The MSS is made up of nine organisations, designed to support and scale small businesses through training, access to expertise, and direct investment. However, it also goes further in promoting entrepreneur activity, including supporting microenterprises with fewer than nine employees, through SEMs (Small Enterprise and Marketing Service), and one-person start-ups through KISED (Korea Institute of Start-Up & Entrepreneurship Development). It also seeks to integrate small start-ups into the existing ecosystem, through public purchase programmes encouraging government to buy from SMEs, linking businesses with relevant university IP, as well as funding research and connecting small businesses to larger enterprises. Uniquely, the MSS is active in reforming policy, tax and regulations requirements that may unfairly burden small start-ups, through an SME Ombudsman who identifies regulations that unreasonably burden SMEs or impact new industries linked to the Fourth Industrial Revolution to systematically remove barriers to innovation[97]. From a tax perspective, start-ups currently receive a 50% discount on corporate tax bills and start-ups in special regions outside of major cities can be eligible for a complete write off[98].

94 WIPO. (2020). World Intellectual Property Indicators 2020. Geneva: World Intellectual Property Organisation

95 UNESCO (2022) How much does your country invest in R&D? accessed: 13 March 2022

96 Gao, J., Jia, R., Su, Q. (2022). Korea. In: G20 Entrepreneurship Services Report. Palgrave Macmillan, Singapore. https://doi.org/10.1007/978-981-16-6787-9_14

97 Ministry of SMEs and Startups. Retrieved 31 March 2022, from https://www.mss.go.kr/site/eng/03/20301030000002019110605.jsp

98 Harman, R., & Park, J. (2021). South Korean tax revision bill includes incentives to spur economy. Retrieved 31 March 2022, from https://mnetax.com/south-korean-tax-revision-bill-includes-incentives-to-spur-economy-45528

Deep dive 2: Israel

Key lessons for the UK from Israel:

Develop human capital with a focus on technical and entrepreneurial skills as early as primary school and throughout higher education, particularly relating to technical skills of graduates.

A global mindset with links to Silicon Valley and the presence of multinational companies to allow knowledge absorption through exposure to new markets and capabilities. Israel's consistent investment in innovation has allowed it to become a global hub.

Bridging the gap between R&D and consumer market through early government investment allows companies in Israel to overcome the 'valley of death' – the space between initial research and successful innovation.

Israel has a long history of investment in innovation and a strong vision focusing on areas of strength such as agri-tech and health, with a well-established and well-recognised innovation ecosystem.

With a population of only 9.3 million, Israel has a strong record of generating and diffusing innovation globally. Israel's success in bridging the gap between R&D and the consumer market has allowed it to produce thriving Israeli companies, with well thought out policies in funding and education developed over decades.

Since the late 1980s, Israel's education system has placed emphasis on teaching technical skills as early as high school, particularly in computer science, developing a pool of talent for both the army, research centres and technological companies[99]. The education system focuses on bridging the gap between traditional subjects and technical skills important for the economy, such as software development. More recently, Israel has launched pilot programs in computer science and robots for primary school curricula[100]. As well as Israel's education system, the compulsory requirement of military service for most citizens in Israel creates a shared experience that produces founders and technologists who are more skilled than in other countries, can work in teams and are technically trained at a high level.

Service in the Israel Defense Forces (IDF) also produces networks of alumni that connect founders and technologists with each other and with employers at a high level. Promising candidates with computer skills are recruited from high schools for elite units that focus on technology such as Unit 8200, and assigned challenging

99 Silicon Valley to Silicon Wadi California's Economic Ties with Israel. (2021). [Ebook]. Bay Area Council Economic Institute. Retrieved from http://SiliconValleyToSiliconWadi.pdf (bayareaeconomy.org)

100 Eddin, Elham Nasser, "Salesforce Appoints Efi Cohen to Head Israel R&D Center," CTech, November 3, 2020, https://www.calcalistech.com/ctech/articles/0,7340,L-3800090,00.html

roles, absorbing technical and command skills at a young age. Many alumni of Unit 8200 and similar defence units start technology companies, building on the networks created by their former military ties.[101] Israel retains a close eye on growing technical skills and talent in cyber and data through its focus on the education system[102]. Israel recently announced a plan to invest $100 million (approx. £79.5 million) over five years to help the Arab community develop skills to work in tech, through educational programmes and vocational training[103].

Government investment in innovation over time has allowed Israel to develop a well-established innovation ecosystem with an emphasis on bridging the gap between R&D and the development of commercial products. In 1991, the government established the Israeli Technological Incubators Program, which created 24 technology incubators that provided support and financing through payments of up to $300,000 (£240,000) for early-stage R&D projects that could be developed into businesses bringing innovative products to market. Israel introduced Yozma, an initiative funded by the Ministry of Finance that invested $100 million (approx. £79.5 million) to create 10 new venture capital funds focused on weaker areas of the market and supporting the development of emerging technologies before they are viable candidates for private investment. In 2020, investment totalled approximately $700 million (approx. £560 million), with more than 4,000 applications reviewed by subject matter experts both for the innovativeness of their technology and its potential for commercialisation, and 45% were approved[104].

Israel has created sector-oriented innovation communities through the non-profit Israel Innovation Institute, including HealthIL (for healthtech), GrowingIL (for aggrotech), CatalystIL (for innovation management), EcoMotion (for smart mobility), DeserTech (for sustainable living in arid climates), and PLANETech (for climate change technology), to advance innovation and the digital economy in specific fields. For example, the non-profit HealthIL, a joint venture of the Ministry of Economy, the Digital Israel National Initiative, the Israel Innovation Authority, and the Ministry of Health, aims to bridge the gap between Israel's technology community and the public health sector through digital transformation. HealthIL links digital health start-ups with organisations that need technology – such as hospitals, healthcare providers

101 Silicon Valley to Silicon Wadi California's Economic Ties with Israel. (2021). [Ebook]. Bay Area Council Economic Institute. Retrieved from http://SiliconValleyToSiliconWadi.pdf (bayareaeconomy.org)

102Israel's surprising way of teaching skills for innovation. [Blog]. Retrieved from http://Israel's surprising way of teaching skills for innovation - ISRAEL21c102 Silicon Valley to Silicon Wadi California's Economic Ties with Israel. (2021). [Ebook]. Bay Area Council Economic Institute. Retrieved from http://SiliconValleyToSiliconWadi.pdf (bayareaeconomy.org)

103 Silicon Valley to Silicon Wadi California's Economic Ties with Israel. (2021). [Ebook]. Bay Area Council Economic Institute. Retrieved from http://SiliconValleyToSiliconWadi.pdf (bayareaeconomy.org)

104 Frenkel, A., Segal, V., Getz, D., & Leck, E. (2011). Towards Mapping National Innovation Ecosystems Israel's Innovation Ecosystem. Samuel Neaman Institute. Retrieved from https://www.neaman.org.il/EN/Files/Israeli%20ecosystem_20170430133818.757_20211010105454.895.pdf

and pharmaceutical companies, and medical device companies. Their role is to integrate digital technology into healthcare[105].

Several multi-national corporations have established R&D centres in Israel, accounting for 50% of business R&D expenditure and exposing Israel to new knowledge, networks and capabilities. Where government investment and emphasis on innovation has matched high levels of FDI, this has also allowed Israel to develop greater resistance to changes in international capital flow when compared to the UK[106].

1.5.3 What institutions is the UK lacking that other countries have?

Because IDA are complex processes, it is not easy to ascribe relative success or failure to the existence of particular types of institutions (or lack thereof), in the UK or other countries. Each county has a context- and historically-specific innovation landscape – many sectors also have a high degree of global interdependence[107]. Research is often now a multinational and inter-disciplinary phenomenon with a global market for technology[108]. The main division is drawn between market economies such as the UK and the US, and countries such as Japan, Korea, and latterly China. The latter are held to be characterised by extensive government support for knowledge building and industrial investment, while the former rely primarily on market incentives and private decision-making[109]. However, this underplays the vital role played by the public sector in the UK in driving IDA.

While generalisation is difficult, the experiences of five leading Public Research Institutes (PRIs) in Germany, Taiwan, Japan, Australia, and the US shows that there are important differences which keep research relevant to industry needs and maintain research standards, specifically[110]:

- The balances between contract research versus longer term research with own initiative
- Mobility of researchers vs. retaining core researchers
- Competitive grants and funds from industry versus block grants from government

From the late 1970s the UK has reversed a century of relative decline per capita GDP compared to the US, France, and Germany, through an array of policy changes

105 “Challenge-Driven Ecosystem for Fostering Healthcare Innovation,” HealthIL, accessed August 10, 2021, https://www.healthil.org; and interview with Yoav Fisher, Head of Technological Innovation and Digital Health, HealthIL.

106 Investing in Innovation. (2015). [Ebook]. Royal Academy of Engineering. Retrieved from http://*investing-in-innovation (raeng.org.uk)

107 Bartholomew, S. (1997). National systems of biotechnology innovation: complex interdependence in the global system. Journal of international business studies, 28(2), 241-266.

108 Spulber, D. F. (2008). Innovation and international trade in technology. Journal of Economic Theory, 138(1), 1-20.

109 Error! Hyperlink reference not valid.

110 Intarakumnerd, P., & Goto, A. (2018). Role of public research institutes in national innovation systems in industrialized countries: The cases of Fraunhofer, NIST, CSIRO, AIST, and ITRI. Research Policy, 47(7), 1309-1320.

including huge investment in education, expanding higher education for more people, and greater competition in product and labour markets. However major weaknesses in investment in human capital and through-life reskilling, infrastructure, and innovation remain[111]. The UK still has a relatively low number of graduates in science and engineering (STEM subjects)[112]. A thriving exports market is likely to be a key component to drive IDA, but the relationship between technology innovation and export performance is stronger in less competitive markets[113].

The UK has a complex innovation ecosystem with over 200 Research and Innovation Organisations (RIOs) (as distinct from universities) including Public Sector Research Establishments (PSRE) - also known as PRIs – plus business support and bridging institutions such as accelerators and catapults, which exist to support and drive innovation[114], including:

- UKRI: A non-departmental public body sponsored by DSIT, made up of nine organisations aiming to convene, catalyse and invest in close collaboration;
- Innovate UK: The UK's national innovation agency, providing companies with access to expertise and resources;
- The Institute of Innovation and Knowledge Exchange (IKE Institute);
- Nesta: An organisation that funds researching innovation focused on a fairer start, a healthy life, and a sustainable future;
- Catapult Network: A network of nine leading technology and innovation centres across the UK.

These RIOs carry out a huge range of supporting and enabling activities, including:

1. Support to industrial innovation, involving scientific development of industry knowledge bases, problem solving and advice, and in-house product and process development;
2. Infrastructure creation and maintenance, involving provision of specialised or large-scale capital goods, instruments and equipment, and storage of scientific and/or industrial materials and data;
3. Public policy development and implementation, involving contributions to policy development and implementation, contingency planning and monitoring for accidents and natural disasters, and social and health innovation.

111 Besley, T., Coelho, M., & Van Reenen, J. (2013). Investing for prosperity: skills, infrastructure and innovation. National Institute Economic Review, 224, R1-R13.

112 https://www.oecd.org/science/inno/2380078.pdf

113 Silva, G. M., Styles, C., & Lages, L. F. (2017). Breakthrough innovation in international business: The impact of tech-innovation and market-innovation on performance. International Business Review, 26(2), 391-404.

114 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/451265/bis-15-321-research-and-innovation-organisations-in-the-UK-innovation-functions-and-policy-issues.pdf

The main characteristics of RIO innovation activities are that they are often long-term, indirect, highly uncertain in outcome, intermittently relevant (i.e., they may become important only in some kind of crisis) and infrastructural in character: “If there is a difference between the UK and ‘developmental states’ it may lie not in the existence of these organisations but in their funding, governance, coordination, strategic direction and links with business” (ibid). This ecosystem can be confusing to navigate and require significant investment of time to engage with, both for innovator/academics and for private sector/customers.

If there is a gap in provision of innovation support services, some suggest it lies at the regional level, as compared with the Fraunhofer Society in Germany[115] which has 75 institutes spread across the country, partnered with a university, each focusing on a different field of applied science (such as microelectronics, materials, surface technology and photonics, life sciences, information technology, and defence) with ringfenced funding and joint marketing efforts[116]. This has been seen by some as a driver of collaboration leading to improved innovation diffusion, along with Germany’s apprenticeship system where the State and employers jointly invest in technical and vocational education. The primary value of these could be seen in the networking effect: a systematic review of the role of networks in innovation showed that that there were benefits to risk-sharing, obtaining access to new markets and technologies, speeding products to market, and pooling complementary skills. National systems of innovation play an important role in the diffusion of innovations, by shaping networking activity: therefore, network relationships with suppliers, customers, and intermediaries such as professional and trade associations are important factors affecting innovation performance and productivity: “Where networks fail, it is due to inter-firm conflict, displacement, lack of scale, external disruption and lack of infrastructure” [117].

In the US, the role and influence of the Defence Advanced Research Projects Agency (DARPA) is often cited as a key driver for innovation[118], with its clones the Advanced Research Projects Agency-Energy (ARPA-E) and the Intelligence Advanced Research Projects Agency (IARPA)[119]. They are highly proactive as public sector intermediaries between science and industry to pursue mission-oriented, high-risk/high-reward, breakthrough research, and also actively promote the follow-on development and implementation of technologies they support in their mission areas, achieving ‘mission innovation’ through setting challenges with prize money attached. DARPA has delivered many breakthrough technologies thanks to substantial public funding and a willingness to take risks and to ‘pick winners’.

115 https://www.fraunhofer.de/en/about-fraunhofer.html

116 Comin, D., Trumbull, G., & Yang, K. (2016). Fraunhofer: Innovation in Germany. Drivers of Competitiveness, 409-444.

117 Pittaway, L., Robertson, M., Munir, K., Denyer, D., & Neely, A. (2004). Networking and innovation: a systematic review of the evidence. International journal of management reviews, 5(3-4), 137-168.

118 Liu, S. (2020). DARPA: A global innovation differentiator. IEEE Engineering Management Review, 48(2), 65-71.

119 Bonvillian, W. B. (2018). DARPA and its ARPA-E and IARPA clones: a unique innovation organization model. Industrial and corporate change, 27(5), 897-914.

The success of these models has led to efforts to duplicate them, most recently as a new Advanced Research and Invention Agency (ARIA) in the UK – this has yet to be set up.

Israel continues to be at the forefront of start-ups with the highest number of new unicorn companies produced per capita[120] and has over 350 R&D centres. The Israel Innovation Authority is a centralised institution that is design to manage frameworks supporting early-stage entrepreneurs as well as mature companies looking to innovate processes or products. The authority oversees six innovation divisions, each providing a toolbox of support and resources to diverse actors in the innovation ecosystem.

In Korea, intuitions focus on bridging the gap between entrepreneurs, R&D facilities and private investment and expertise. As well as the MSS the Tech Incubator Program for Start-ups is open to any tech start-up with a technical R&D plan. The incubator provides a number of accelerator programmes with up to 1bn KRW financial support for up to three years. The government actively shares the risk of business failure and provides R&D funding while TIPS partners from the private sector are appointed as angel investors and incubators for fledgling companies[121]. This scheme is only open to tech start-ups with Korean citizens as co-CEOs owning at least 60% equity however the Korean government also runs parallel initiatives to attract foreign start-ups. The K-Startup Grand Challenge (KSGC) is a scheme that offers foreign start-ups an accelerator programme to help launch their organisation in Korea. This package includes corporate sponsorship, free project space, living expenses and mentoring. The connecting theme across all three of these Korean institutions is a focus on micro start-ups as well as SMEs[122].

120 Schachem, R., Meridor T. (2022) Israel's Tech Ecosystem – Breaking Records in a Record Breaking Year EoY report by Viola Data

121 http://www.jointips.or.kr/about_en.php

122 https://www.k-startupgc.org/board/board_view.do?bd_idx=290

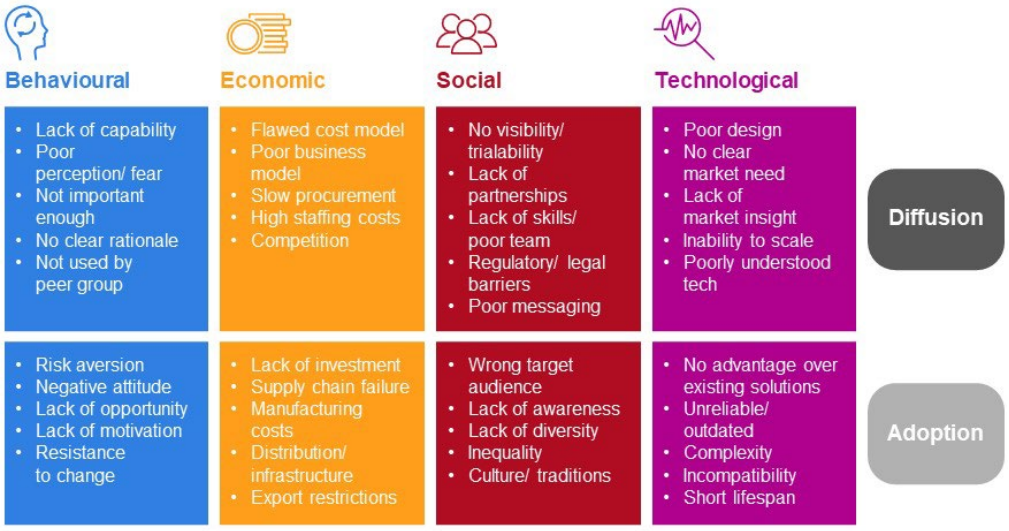
1.6 What are the barriers to innovation diffusion and adoption?

Many innovations and start-ups fail, for a range of behavioural, economic, social and technological reasons, which are often interdependent and co-existing. Diffusion can experience different barriers to adoption. Barriers to diffusion include development costs and lack of investment, poor design, lack of market insight, lack of collaboration, lack of skills, regulatory/legal environment, and poor perceptions/fear of the 'new'. Barriers to adoption include flawed cost and business models, slow procurement, unreliability, wrong target audience, lack of diversity, inequality, cultural barriers, and risk aversion.

1.6.1 Four groups of factors

Getting a new idea adopted, even when it has obvious advantages, is often very difficult[123]. There are many reasons why an innovative idea, product, service or behaviour may or may not become diffused and/or adopted. The factors that influence diffusion are not always the same as those which influence adoption. This is because diffusion covers the 'push' elements that allow an innovation to spread; while adoption includes all the 'pull' elements that allow an innovation to become widely used. There are various 'lenses' through which these push/pull processes can be viewed: behavioural, economic, social, and technological. These barriers may be present to a greater or lesser extent depending on the sector's particular context, maturity, and type of people.

Figure 11: Barriers to IDA.



Source: PA

123 Rogers, E. M. (1995) Diffusion of Innovations, Fourth Edition. The Free Press.

1.6.2 Barriers to innovation diffusion

1.6.2.1 Behavioural barriers to innovation diffusion

Arguably one of the most persistent barriers to IDA is behavioural factors both internal to businesses or beyond. They include: a lack of capability to make use of the innovation, or otherwise being unable to access it (for example not being able to afford it, not having the right infrastructure in place, or disability); having a poor perception of the innovation, which may have a bad reputation/image/brand, cynicism over new things, or fear of the new and unknown; the innovation not being seen as important or useful, or otherwise misaligned with personal identity ('it's not for me'); the innovation having no clarity of rationale or purpose; or not being used by our peer-groups and/or communities. Further research is required to better understand the relative importance of these factors.

1.6.2.2 Economic barriers to innovation diffusion

Research and anecdotal evidence suggests, economic factors that influence innovation diffusion are around costs, logistics, and wider market potential. Start-ups can sink money into upfront costs for development and production that take too long to pay back. Without attracting seed investment rapidly, the only option is 'bootstrapping' (where new product development is self-funded by the founder/friends and family, and/or an early-to-market product receives some early sales which generate enough operating revenue to reinvest in further development – although this is more suited to some kinds of innovation than others). A lack of cashflow has killed many start-ups, which often operate on tiny margins. Scale-up businesses can face similar issues around investment, with much larger sums needed to scale up and go into full production. Failure to raise sufficient funding is a major issue – especially when the product is still new and untested in the market, or the business case is not yet sufficiently proven for Series A financing (Series A is a company's first significant round of venture capital financing in exchange for equity, or partial ownership). While sometimes banks are willing to provide scale-up loans, and Innovate UK have created Innovation Loans, often there is insufficient awareness of the funding available for commercialisation and scaling up.

As a business scales up, and especially if it has scaled rapidly having had more-than-anticipated early success, the business may find it has more orders than it can handle, not enough stock and its supply chains are unable to respond rapidly. Being unable to meet sales/demand, or having an unreliable/unsuitable supply chain, can prevent innovations developed by businesses from being produced quickly enough to be diffused and adopted for others to use. For most products (rather than services) there are costs to manufacturing at scale that can be prohibitively high: if the success of the product relies on selling lots at low cost rather than a few expensive products to a small market, then manufacturing costs can prevent rapid diffusion. Diffusion more widely to countries can also be prevented in some cases by

restrictions on exports, either through a direct ban (depending on what the technology/product is – for example for some defence and national security equipment) or a bureaucratic/tax regime that makes it unprofitable to do so.

1.6.2.3 Social barriers to innovation diffusion

Much research has focused on social and behavioural barriers, where the challenges have not so much been an inability to create and bring a new product to market, or knowing what change needs to happen, as convincing people of the need to change and persuading them to implement those changes. Innovation usually means doing things differently, or trying something new, which translates into uncertainty, expenditure of money and energy. It can be very psychologically challenging to make a change – which is why we find habits hard to break. It can be difficult to evaluate the value of making the change, compared to the effort involved in doing so: this is why social and behavioural effects are at least as important as economic and technological factors. Public sector policy innovation in regional and local organisations, such as health, policing, education, and local government[124], can be a driving force for IDA; but diffusion can also be hindered by tribal 'not invented here' attitudes.

Research suggests that the social barriers to innovation diffusion include how visible, or observable an innovation is. If an innovation can be seen, trialled, played with, and explored it is more likely to become more widespread. There is also evidence that greater collaboration and building partnerships with others who have similar interests/purpose to pool efforts and resources, can help innovations diffuse: conversely a lack of partnerships or collaboration is a potential barrier. Both visibility and partnerships can be inhibited by an excessively competitive environment, where people are unwilling to share their ideas, showcase an innovation, or partner with others.

> **Survey spotlight**: The global 'Innovation Matters' survey showed that only 24% of people were fully confident they have defined the skills and activities they need to innovate.

People are a company's most important asset. Start-ups often have an entrepreneurial mindset where everyone does a bit of everything, and sometimes founders have a 'hero' complex which can make them harder to work with in a larger business setting, where more people need to feel invested in decision-making. Innovations can fail to become diffused because of the business failing to attract and retain the right skillsets it needs to grow, and a lack of expertise. In some cases,

124 Xing, Y., Liu, Y., & Cooper, S. C. L. (2018). Local government as institutional entrepreneur: Public–private collaborative partnerships in fostering regional entrepreneurship. British Journal of Management, 29(4), 670-690.

founders/teams/investors have fallen out over personality clashes/lack of shared vision, leading to the business being scrapped. Running a start-up is notoriously hard work, and the burnout rate for entrepreneurs is uncomfortably high.

In some sectors, an innovation must navigate a complex commercial/regulatory/legal/policy environment – or may even face ethical challenges – all of which inhibit experimentation. Regulation and law can be very slow to respond to emerging technologies, and often lag (sometimes by many years). This can prevent or slow down the development and commercialisation of promising or potentially revolutionary innovations. Too much bureaucracy is a common complaint among start-up and scale-up business leaders.

Social barriers to innovation diffusion can also include wider public opinion, which can be influenced by social media and mainstream media messaging. Public perceptions can be swayed by a high-profile scandal, marketing misfire, or misunderstanding of what an innovation is for, or an unfortunate incident where an innovation is misused, leading to reputational damage that can prove fatal for an innovation. Sometimes the poor reputation is entirely justified and exposes a gap in the thinking of the inventor – for example a blindness to the potential misuse of the technology or whether it may introduce bias or discrimination.

1.6.2.4 Technological barriers to innovation diffusion

The technology itself may be a barrier to diffusion. A technology may be highly novel, but the prototype poorly designed – for example it works well for some groups of people but is inaccessible to others. If there is no clear understanding of market needs, customer requirements and the problem that must be solved, a technology which works in isolation under a specific set of conditions may fail once it reaches a real-world setting. The idea may simply be ahead of its time, and either the technology itself or the wider context is not yet ready for the development. Too often, inventors don’t connect with customers and money and time is invested into developing protypes without the necessary market insight and early customer engagement to get feedback; while customers sometimes get caught up in the hype without understanding the maturity of the product and how much investment would be needed to make it viable.

Another issue with the technology may be an inability to scale up manufacture – for example, the product is made of too many complicated components and materials that take too long to assemble. It may not be possible to adapt and iterate through the product development cycle. The technology may be too new, poorly understood or need more research before it can go any further.

Whichever multiple barriers to diffusion an innovation has suffered, the outcomes can include failed start-ups, a lack of awareness of the innovation’s potential, and/or a new product/service not being widely available or being inaccessible to people.

1.6.3 Barriers to innovation adoption

1.6.3.1 Behavioural barriers to innovation diffusion

> **Survey spotlight**: We asked over 70 survey respondents about barriers to innovation adoption: attitude to change was top; followed by complexity of implementation; and lack of knowledge and skills.

As with diffusion, individual behaviours can be key to innovation adoption. People can have varying levels of risk appetite and aversion, depending on their personality, level of experience, responsibility and role. While often an unwillingness to take risks is sensible, it is cumulatively deadening both to innovation and the enthusiasm of innovators. Cognitive biases such as confirmation bias (favouring information that confirms pre-existing beliefs), conformity (groupthink, going with the majority view, lack of considering divergent viewpoints), loss-aversion bias (attaching more value to something once you have invested in it) and framing bias (being influenced by the way information is presented and by whom, rather than the information itself) all mean people can struggle to objectively consider relative risk, leading them to reject innovations even if the evidence suggests they should adopt them. Many entrepreneurs may exhibit optimism/strategic misrepresentation bias, knowingly understating the costs and overstating the benefits.

Negative attitudes towards the innovation either from the individual or others around them (especially senior leaders) can prevent innovation adoption. Many organisations cite a lack of senior buy-in as a key hindrance to innovation adoption – for example to new IT or data solutions where senior leaders may be used to what they know and are familiar with. Many people resist proposed changes, for all sorts of personal reasons: distrust, poor previous experiences, or out of tribalism/loyalty. People may also lack the opportunity or motivation to adopt an innovation, through habit, inertia, or lack of focus.

1.6.3.2 Economic barriers to innovation diffusion

Various economic factors influence innovation adoption. The product/service innovation may have a flawed cost model and be marketed at too high a price point: but lower prices may make it unprofitable to make. The company may have spent too long waiting for slow procurement processes to adopt the innovation and been forced to pivot to other markets/offers in the meantime. Or perhaps sales were too slow to maintain production. Competitors may also have entered the market if the originators were too slow, leading to greater competition than anticipated and a race to the bottom on prices.

An innovation may fail to become adopted because the business model itself was wrongly conceived and designed, leading to the company failing to scale up (at pace) – for example, the company gave away too much equity at early stages to be

investable, or became subject to a buy-out or takeover so a promising early innovation which was widely diffused fails to reach widespread adoption. As it grew, the business or its investors may have changed their minds and shifted purpose, or the nascent company may have undergone multiple changes of people and purpose, leading to paralysing uncertainty and an inability to move forwards. The company may have brought on board too many expensive senior staff too early, leading to high staffing costs draining the business financially.

1.6.3.3 Social barriers to innovation diffusion

Social factors also play a major role in innovation adoption. Social barriers to innovation adoption are complex but include the perceived desirability of the innovation (why people would want it), targeting the wrong demographic/audience, or producing an idea that is too niche. Sometimes the wider context has changed – for example changing attitudes to smoking or drinking alcohol – or people's priorities have changed. People may be unaware of the innovation, due to ineffective marketing, or the wrong influencers – or reject it due to lack of trust.

Lack of diversity can lead to innovations not becoming widely adopted, as failing to be inclusive and thoughtful towards all sectors of society can lead to practical, cultural, perceptual and ethical reluctance to adopt an innovation[125]. Intersectionality between ethnicity, gender, age, disability and class/socioeconomic status can all have implications for innovation adoption likelihood, including varying perceptions, motivations, attitudes, and support needs. The UK compares poorly to some other countries in gender imbalance in entrepreneurship[126]: start-up funding was highlighted as the number one barrier[127]. Having a more diverse inventor community helps raise levels of patenting[128], but among the UK venture finance community, almost half (48%) of investment teams in the UK had no women at all.

Inequality is both a key barrier and driver of innovation adoption. Over the past few decades, innovation and technological change has disproportionately benefitted richer people, both in accumulating wealth and improving generational life chances. The gap between rich and poor in life capabilities will continue to widen unless the innovation agenda is transformed. However, arguably, the model in which private firms are the driving force for innovation for profit will never resolve issues of inequality and poor life chances[129]. The digital age has reduced the barriers to adoption for many, as distribution of many ideas and some products has become

125 Jones, R., & Wilsdon, J. R. (2018). The Biomedical Bubble: Why UK research and innovation needs a greater diversity of priorities, politics, places and people.

126 The Alison Rose Review of Female Entrepreneurship (2021), https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/784324/RoseReview_Digital_FINAL.PDF

127 British Business Bank, UK VC & Female Founders report, February 2019, https://www.british-business-bank.co.uk/uk-vc-female-founders-report/

128 Nathan, M. (2015). Same difference? Minority ethnic inventors, diversity, and innovation in the UK. Journal of Economic Geography, 15(1), 129-168.

129 Cozzens, S. (2016). Georgia Institute of Technology.

almost cost-free – yet too many are still unable to access the innovations they need to improve their lives[130].

Many anthropologists have explored socio-cultural barriers to innovation adoption, where traditional or religious practices may prevent adoption. Where an innovation transgresses a social norm, belief system or cultural rule (perhaps around particular groups of the society) it is much less likely to become adopted and may meet active and even organised resistance[131] even if the outcome is demonstrably poorer for the group. Organisational cultures can also inhibit innovation adoption, through 'not invented here' syndrome, change fatigue, fear of failure, resistance to change or excessive bureaucracy. User-led innovations, where development has been with and alongside the end users, or at least through intermediaries, are less likely to experience these barriers[132].

1.6.3.4 Technological barriers to innovation diffusion

Technology factors preventing successful adoption can include: the innovation having no relative advantage over existing technology solutions/being outcompeted by newer technology; the technology being unreliable or outdated; being too complex (hard to use, hard to maintain, hard to fix); being incompatible with existing technology requiring more costly changes; or having too short a lifespan and needing replacing too often (if it is expensive and difficult to do so).

Whatever the reasons for an innovation failing to become adopted, the outcomes include a new company going out of business through lack of profit, or only a few people using a new product/ service, and/or the desired social/behavioural change fails to materialise.

130 Beekhuyzen, J., von Hellens, L., & Siedle, M. Cultural Barriers in the Adoption of Emerging Technologies. Griffith University Brisbane.

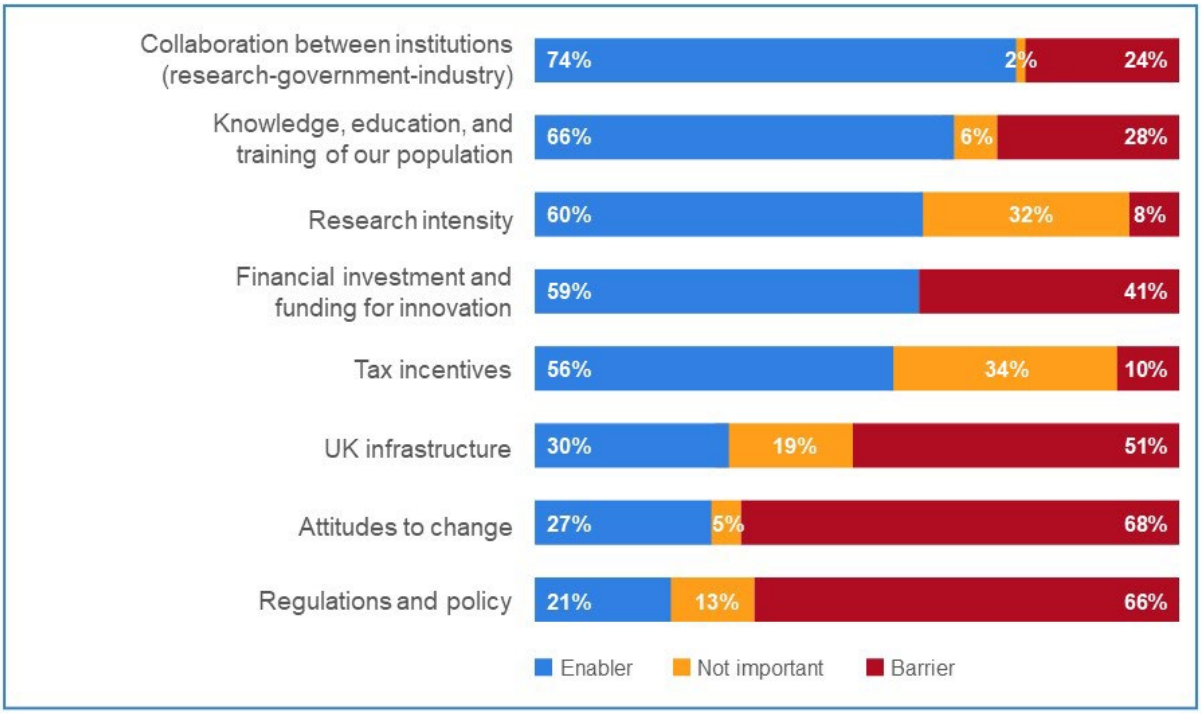
131 Deligiannaki, A., & Ali, M. (2011). Cross-Cultural Influence on Diffusion and Adoption of Innovation: An Exploratory Case Study to Investigate the Social-Cultural Barriers. European, Mediterranean & Middle Eastern Conference on Information Systems 2011. Retrieved from https://bura.brunel.ac.uk/bitstream/2438/8464/2/Fulltext.pdf

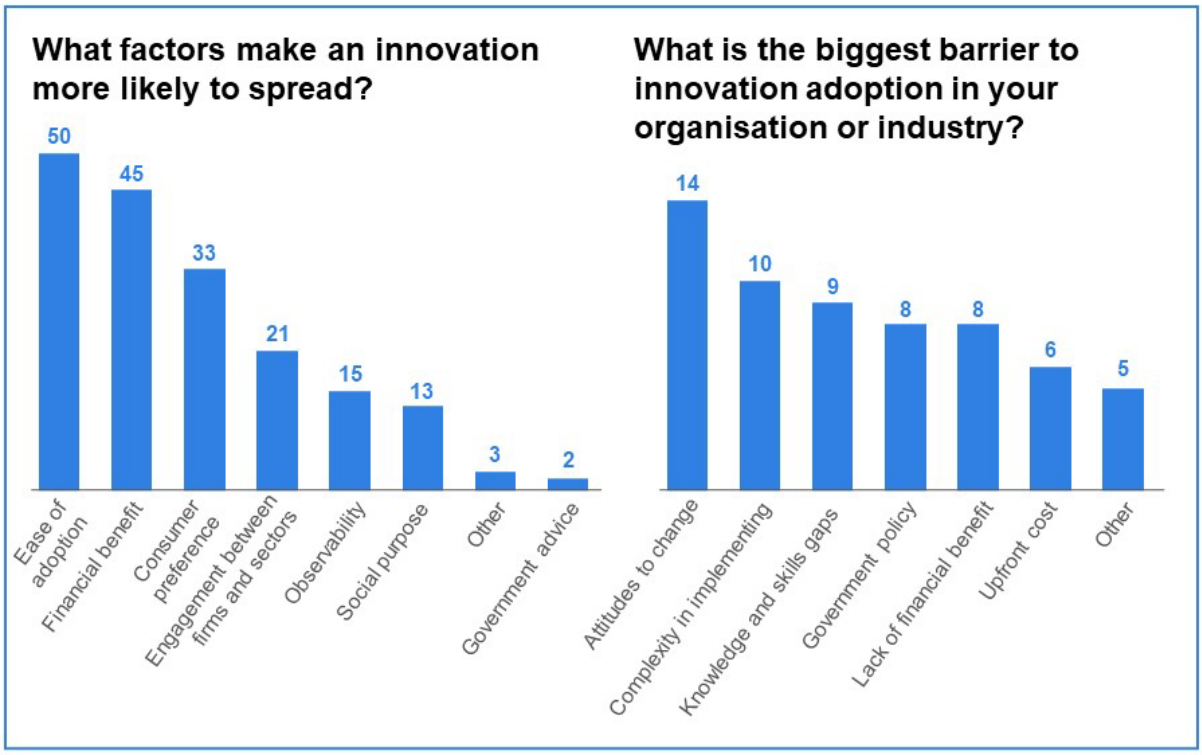
132 Aquilani, B., Abbate, T., & Codini, A. (2017). Overcoming cultural barriers in open innovation processes through intermediaries: A theoretical framework. Knowledge Management Research & Practice, 15(3), 447-459.

Innovation Diffusion and Adoption Survey: Key Findings

70 responses received

- 25% said that innovations are spread in their sector in reaction to disrupters: only 6% said it was through Government advice.
- 22.9% said that innovation was first communicated via professional networks as the most important source of information; second were research institute communications (13.1%) and new disrupters/ small businesses (12.6%). Government was the least important source.
- 25.3% said that meeting consumer needs was the most important factor in deciding to adopt an innovation; second more important was making financial savings/ profit (22.0%) least important driving factor in this group (which had a majority of Early Adopters).
- The most important barrier to adoption was attitudes to change, followed by complexity of implementation, and knowledge and skills.




What factors make an innovation more likely to spread?
50
45
33
21
15
13
3
2
Ease of adoption
Financial benefit
Consumer preference
Engagement between firms and sectors
Observability
Social purpose
Other
Government advice
What is the biggest barrier to innovation adoption in your organisation or industry?
14
10
9
8
8
6
5
Attitudes to change
Complexity in implementing
Knowledge and skills gaps
Government policy
Lack of financial benefit
Upfront cost
Other

2 Future innovation diffusion and adoption in the UK

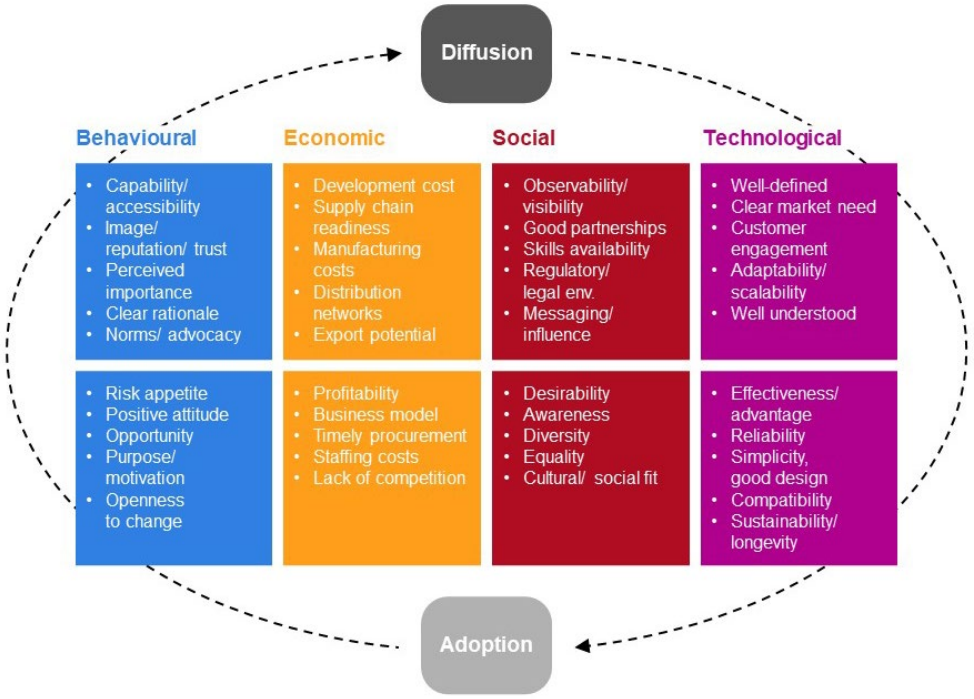
Successful IDA needs the right funding, structures, processes and people to become more effective. People can align around a shared sense of purpose, where there is a big challenge to solve or a common vision of what needs to change. Innovation can also be driven by mandate and law, such as health and safety – but even these changes will be better adopted if they align with a sense of purpose, vision and motivation. Behavioural science theory can help 'nudge' people provided they also have the capability, opportunity and motivation to alter behaviours. For these disparate elements to come together IDA must be defined, measured, and explored.

2.1 How should innovation adoption and diffusion be defined?

IDA is supported by behavioural, economic, social and technological drivers. The BEST logic model of innovation success factors captures these and provides a framework to understand, measure and explore IDA.

2.1.1 The BEST model

Figure 12: The BEST model for IDA.



Source: PA

These success factors can be flexibly applied to different types of innovation in different sectors, product and services innovation, business growth and organisational innovation, and wider social or behavioural changes. However, not all factors will be relevant for all types of innovation in every circumstance. Success factors for product innovation have been well studied but not generally separated into factors for successful diffusion (such as having the right product at the right time for the right market, early customer engagement and feedback, and clearly defined/differentiated product) and successful adoption (such as being profit-making, market share, and having a clear advantage over existing technology) [133] [134]. This logic model takes a wider view but draws out common factors. If these economic, technological, social, and behavioural factors can be aligned, an innovation has a much greater chance of being diffused and then adopted – leading to a positive cycle where higher diffusion leads to greater adoption, which further diffuses the innovation even more widely.

2.1.2 Enablers for innovation diffusion

2.1.2.1 Behavioural enablers for innovation diffusion

Individual behaviours are important for IDA. Doing more to support an individual's resources, capacity and capability to access and adapt to an innovation is likely to aid diffusion. Individual perceptions of the innovation are important as well, which can depend on their level of knowledge, sources of information, trust and the image/reputation of the innovation, brand and business. An innovation perceived as important to them is more likely to be diffused, especially if there is a clearly self-evident rationale for doing so. Ideas also spread as a 'meme' through mimicry, as people copy their peers and in-crowd to emulate them, for example to increase status.

2.1.2.2 Economic enablers for innovation diffusion

Economic factors that influence innovation diffusion are primarily around costs, logistics and wider market potential. Making development costs lower, or more affordable, and providing additional investment and support for scale-up businesses would help scale-up companies bring new products to market more quickly. Businesses can also improve the likelihood of innovation diffusion by ensuring supply chain readiness/resilience, factoring in manufacturing costs early on and redesigning if necessary, putting time and effort into the right distribution channels, and ensuring the infrastructure is in place and is well understood. Businesses can also explore exports as a potential route to rapid growth.

133 Cooper, R. G., & Kleinschmidt, E. J. (1987). Success factors in product innovation. Industrial marketing management, 16(3), 215-223.

134 Cooper, R. G. (1999). From experience: the invisible success factors in product innovation. Journal of product innovation management, 16(2), 115-133.

2.1.2.3 Social enablers for innovation diffusion

Social factors are critical for innovation diffusion, including observability/visibility/trialability (having samples available to explore at low risk, so people can get used to the new idea). Being collaborative, using open innovation models and having the right partnerships in place all help innovations diffuse. Creating a diverse, high performing team with the right skills mix is vital, including the right leadership. As a company grows, it needs to carefully consider the right people to bring in and what skillsets they will need, as well as the mix of personalities and backgrounds to avoid homogeneity and groupthink occurring.

Having the right regulatory, ethical (i.e., use of data and innovation), and legal frameworks to support innovation is important: new constructs could help provide safe spaces for experimentation (sandboxes); while early and regular engagement with regulatory authorities and policymakers helps to ensure the innovation is not unduly delayed by red tape.

Positive messaging and influences can improve innovation diffusion: while innovation diffusion models can also help marketers understand how to segment and approach different target markets (early adopters versus early majority). Understanding consumer behaviours and reasoning plays a key role in positioning a new product or service for maximum impact and awareness, while consumers can also be drivers of innovation through co-creation models.

2.1.2.4 Technological enablers for innovation diffusion

As we saw from the list of barriers, having the right technology and the right product is crucial to successful diffusion. Technologies that are easy to understand and are well-defined are less likely to face barriers to diffusion. Having a clear understanding of the market need and a differentiated product helps, as does early customer engagement/feedback to iterate accordingly. A technology which can be readily adapted and scaled is more likely to be diffused (which is why software is more innovative and faster to market than hardware). Ideally the technology itself should be well researched, tried-and-tested, and understood.

The outcomes of improved innovation diffusion are that more scale-ups grow into successful businesses; that people are more aware of innovations; and new products/services are widely available.

2.1.3 Enablers for innovation adoption

2.1.3.1 Behavioural enablers for innovation adoption

Innovations become successfully adopted when behavioural, economic, social, and technological factors align to support adoption. Sometimes momentum can grow, leading to rapid adoption.

Behavioural factors that facilitate innovation adoption are critical, as ultimately adoption depends on whether individuals choose to take on the innovation or not. This area could benefit from a multidisciplinary approach incorporating social, behavioural science and psychology to explore the 'nudge', and interventions that could help persuade people to adopt beneficial innovations. Increasing risk appetite to help people take considered risks can be bolstered by tapping into cognitive biases such as bandwagon bias (preferring ideas already adopted by others, especially when the others are high status); pro-innovation bias (especially among innovators and early adopters, the love of novelty as inherently good and desirable – however this can lead to blindness towards potential negative impacts); and optimism bias (focusing on benefits while ignoring negative information).

Having a positive attitude towards innovation and being open to change are psychological factors that vary from individual to individual: but there is some evidence that getting the right person in the right roles – especially into leadership roles – can help engender a positive innovation adoption environment. Giving people both opportunity and motivation to adopt innovations makes it more likely that they will do so.

2.1.3.2 Economic enablers for innovation adoption

Economic factors that aid adoption are relatively straightforward and well understood, including: profitability; having an effective business model optimised for growth; timely procurement processes; reasonable staffing costs; and competition.

2.1.3.3 Social enablers for innovation adoption

Social factors that encourage innovation adoption include the desirability of the innovation and how aware people are of it. Increasing diversity throughout the IDA processes will improve the chances of an innovation becoming adopted. An innovation that has been developed with a diverse and inclusive mindset is more likely to work for, and please, a wider cross-section of society and more likely to have spotted any issues earlier on in the development process[135].

Equality is a key driver of innovation adoption. A more equal society is more likely to be open to and adopt innovations, with fewer barriers between early adopters and the early majority as innovative products and services are more likely to be affordable, accessible and attainable – as well as being observably used by peer-groups, encouraging individual take-up. A good fit between the innovation and social norms/culture will also ease adoption.

135 Innovation Caucus. (2022). Supporting diversity and inclusion in innovation [Ebook]. Retrieved from https://www.gov.uk/government/publications/supporting-diversity-and-inclusion-in-innovation-study

2.1.3.4 Technological enablers for innovation adoption

Technologies that are effective and have a clear advantage over existing technologies are more likely to be adopted quicky. Ideally, the technology would also be reliable for adoption to be sustained. Technologies that are relatively simple and less complex are more likely to be understood and therefore adopted, with a greater sense of trust in the technology. Being compatible with existing technologies can reduce barriers to entry and make it more likely to be adopted. A technology which has a longer shelf-life, is more sustainable and has greater longevity is also more likely to be worth the investment of adoption.

The outcomes of innovation adoption are that most people use the innovative product/service, and it becomes the new norm, or that the desired social/behavioural change becomes widespread and reinforced by others. A successful new product or service means a business makes profits, creates jobs, and contributes to UK prosperity.

2.2 How can innovation diffusion and adoption be measured?

Current metrics for innovation focus on numbers of start-ups, or patents: none of those are useful for measuring IDA. PA has proposed new metrics built from the BEST IDA model which can be applied flexibly to all types of innovation (product, services, organisational, social and behavioural change) and across a variety of sectors, locally, regionally, and nationally. The model incorporates multivariate factors, including social and behavioural, as well as economic data. These provide a 'balanced scorecard' framework that can give trend data, permit cross-sector comparison and highlight areas for improvement/maturity. As there are gaps where data is not currently systematically collected, a new National Innovation and Diffusion Survey should be developed to gather and evaluate this information, with an annual report on progress highlighting best practice.

2.2.1 Proposed metrics

Different metrics are relevant for diffusion and for adoption: a blended multivariate approach that combines economic, technological, social and behavioural measures is most likely to capture the key characteristics that relate to IDA. Various systems of measuring innovation have been proposed, but these focus narrowly on specific areas of technology adoption, such as compatibility, relative advantage, and

complexity[136], or seek to measure outputs rather than inputs[137]. None of these capture the full range of success factors for IDA.

PA has used the success factors identified for IDA to create a new set of metrics, combining qualitative and quantitative data: where this data is not currently available at a national level, PA proposes an annual survey to capture it. Economic and technology metrics for IDA are more quantitative, while social and behavioural metrics are more qualitative. PA proposes metrics where available but, in many areas, information is not currently available. Depending what type of information/data is required, various types of survey may be needed, ranging from: a small survey intended to be conducted internally within the seller organisation; a small survey intended to be conducted externally to experiment using the product/service; a large survey intended to be conducted externally to measure the perception of the product/service; and a wider survey conducted externally to measure the branding of the product/service. The flexibility of the model means that it can be used for different purposes, audiences and with different constraints. For organisational purposes, it can be applied to a business looking to adopt a technology or sell a product/ service.

Table 1: Metrics for IDA.

Innovation Diffusion	Proposed Metrics	Innovation Adoption	Proposed Metrics
Behavioural: Capability/ accessibility	The number of people who can access the product/service and know how to use it	Behavioural: Risk appetite	The number of risks in adopting the product Willingness to adopt
Behavioural: Image/ reputation/ trust	Percentage of people who think product/service is trustworthy and aligns with their values	Behavioural: Positive attitude/ leadership	The number of individuals that influence others to adopt/not adopt the product, and the strength of their positive/negative opinions about the product/service.

136 Tornatzky, L. G., & Klein, K. J. (1982). Innovation characteristics and innovation adoption-implementation: A meta-analysis of findings. IEEE Transactions on engineering management, (1), 28-45.

137 Edquist, C., Zabala-Iturriagagoitia, J. M., Barbero, J., & Zofío, J. L. (2018). On the meaning of innovation performance: Is the synthetic indicator of the Innovation Union Scoreboard flawed?. Research Evaluation, 27(3), 196-211.

Behavioural: Perceived importance	The level to which people believe the product/service is critical to meet a market need	Behavioural: Opportunity	Percentage of people for whom product/ service is available to use
Behavioural: Clear rationale	Number of people who understand the innovation	Behavioural: Purpose/ motivation	Percentage of people who agree with the purpose of the innovation
Behavioural: Norms/ advocacy	The depth and breadth to which people advocate for the product/service	Behavioural: Openness to change	The level of disruptiveness that the product/service has and the willingness to adopt the product anyway
Economic: Development cost	Average costs of development by type of product/service	Economic: Profitability	The amount of profit generated from buying the product/service
Economic: Supply chain readiness	Supply chain readiness, response, and recovery measures	Economic: Business model	Average rating of the presence of customer, service, technical, organisational, financial perspectives, value exchange, information exchange, and process alignment in the business model.
Economic: Manufacturing costs	Average costs per 1,000 manufactured, by type of product/ service Manufacturing location	Economic: Timely procurement	Define a threshold for a good procurement time, take the average ranking of the procurement process time against the threshold and the number of errors found from the procurement process.
Economic: Distribution networks	The number of facilities used to store and transport the physical	Economic: Staffing costs	The cost of people working to ensure the

	product/service to the customer. The efficiency of the network captured through a survey.		product/service is adopted
Economic: Export potential	Average rating of the current supply capacities, target market's demand and market access conditions	Economic: Lack of competition	Quantitative measures to the number of alternative solutions include patent and google hype data using a set of search terms to describe the solution. Qualitative measures include desk research of alternative solutions.
Social: Observability/ visibility	The number of people who have seen the product/service in use	Social: Desirability	The number and type of people that would buy/use the product/service
Social: Good partnerships	The number of organisations involved in the commercialisation of the product/service e.g., technology transfer, industry partnering The quality of the partnership.	Social: Awareness	The number of people who are aware that the product/service exists as a percentage of the target audience
Social: Skills availability	Define a set of criteria (e.g., degree titles, certifications) and collect data on the number of people in a country with this requirement. Qualitative survey of what people think/experience.	Social: Diversity	The demographic of the people that know about and want the product/service
Social: Regulatory/	Whether the regulatory/ethical/legal	Social: Equality	The demographic of people that can buy

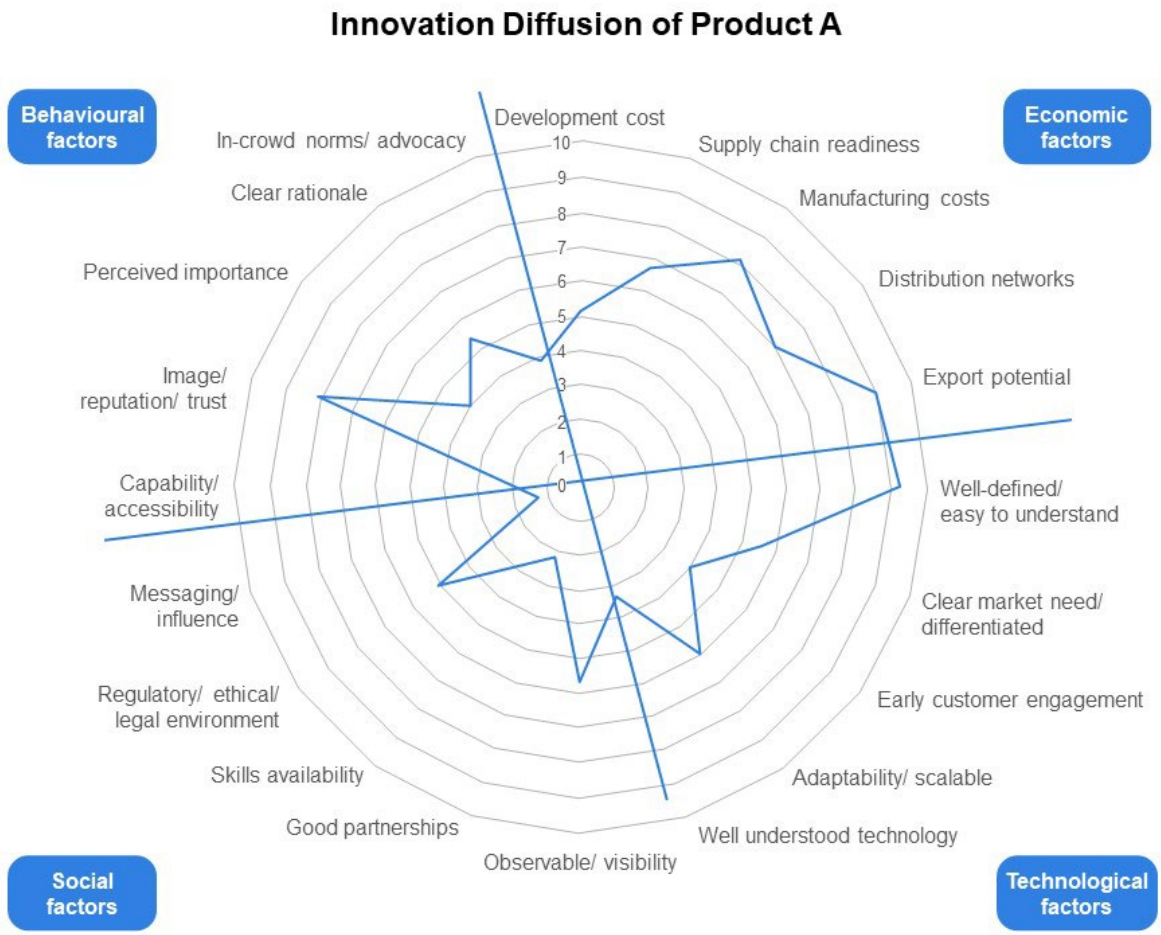
legal environment	enablers outweigh the barriers		and use the product/service
Social: Messaging/ influence	The effectiveness of the branding of a product/service	Social: Cultural/ social fit	The reciprocal of the amount of cultural/ social issues there are and the extent to which they block adoption.
Technological: Well-defined/ easy to understand	The usability of the product/service measured by customer survey and focus group feedback	Technological: Effectiveness/ advantage	Define a set of KPIs, taking the average result of performance metrics (SWaP – size, weight and power if product for example), compare to existing solutions in the market.
Technological: Clear market need	Taking the average result of patent and google hype data with queries related to the product/service and market need.	Technological: Reliability	The reciprocal of the errors the product/service produces
Technological: Customer engagement	The number of customers within the first year of product/service development	Technological: Simplicity, good design	The reciprocal of the number of manoeuvres to use the product/service
Technological: Adaptability/ scalability	The level to which the product/service can adapt for other uses and can scale	Technological: Compatibility	The level that the product/service fits into the current infrastructure
Technological: Well-understood	The number of people who can use the product/service	Technological: Sustainability/ longevity	Average order total multiplied by the average number of purchases in a year multiplied by average retention time in years.

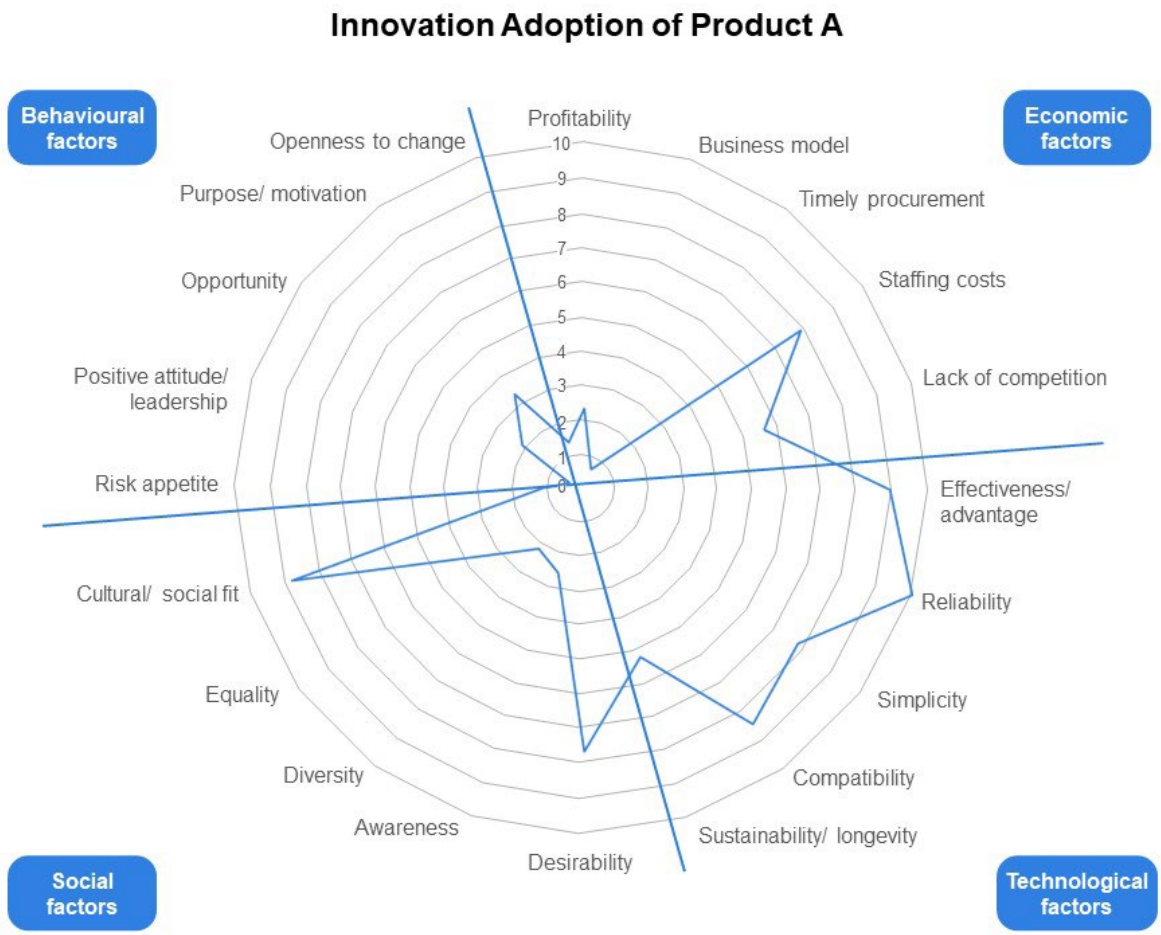
Source: PA

2.2.2 Modelling IDA

These metrics can be used to convert to a maturity model, bringing all the success factors together to show, across these multiple dimensions, how likely an innovation is to become diffusion, and adopted. This can be adapted at a national, regional/local, or organisational level, and to products of different types as well as services, and social/behavioural change models. The higher scoring each element is, the more likely it is that the innovation will be diffused/ adopted:

Figure 13: Examples of how metrics of IDA success factors could be visualised as a maturity model.





Source: PA

2.3 What policy initiatives could improve innovation diffusion and adoption?

Though help to grow is already available, more could be done in targeted policy interventions specifically focused on IDA, this would form a natural link with government priority to improve productivity. This could include increasing support for scale-ups, creating new funding mechanisms for IDA – such as an Innovation Diffusion and Adoption Fund – and creating innovation experimentation 'skunkworks' freed from the usual regulatory and legal constraints.

2.3.1 Policy mix

Governments have many policy options available to them to encourage IDA: funding (direct and indirect), macro-economic policies (tax incentives, subsidies), industrial policies (how the Government will set demand signals and engage with industry), regulatory policy; skills and education policies; R&D, science and technology policy; and innovation policy. Government can flex these levers to complement one another

(the 'policy mix')[138] – noting that interventions are often multi-faceted and overlapping[139]. Having sustained investment over many years (or decades in some sectors), and a predictable policy environment, are key to market confidence to invest resources and financially in innovation.

2.3.2 Potential solutions to increase innovation diffusion and adoption in the UK and areas to further research

The spread and uptake of life-changing innovation can bring many social and economic benefits and provide solutions to long-standing challenges, therefore IDA should not be left to luck, chance, or market forces. The benefits of innovation are well known (such as social or economic), without the successful diffusion and adoption of innovation opportunities of creating thriving markets could be lost. Based on this research, there is a strong case for further research into understanding IDA and investing in solutions to increase our ability to ensure great innovation is diffused and adopted. The below explores potential solutions to key findings in this research and further gaps to address.

Table 2: Potential solutions and gaps for further research into IDA in the UK.

Model Component	Potential solutions to explore	Identified areas for further research
Behavioural Capability/ accessibility Image/ reputation/ trust Perceived importance Clear rationale Norms/ advocacy	Directly incentivise IDA-specific activity Monitor metrics focused on IDA through a National IDA Survey Tackle information gaps through trusted networks	The potential role of a national or shared purpose in expediting IDA Cognitive-bias and socio-cultural barriers
Economic Development cost Supply chain readiness	Increased public funding and support for scale ups Tax credits for diffusion/ adoption activities (not just for R&D) Showcase UK innovation internationally (with grant funding to participate)	Role of the foreign direct investment in IDA Impact of public sector buying power Collaborative co-investment structures

138 Borrás, S., & Edquist, C. (2013). The choice of innovation policy instruments. Technological forecasting and social change, 80(8), 1513-1522.

139 Hemel, D. J., & Larrimore Ouellette, L. (2018). Innovation policy pluralism. Yale LJ, 128, 544.

Manufacturing costs Distribution networks Export potential		Increased access to publicly funded/subsidised business and marketing support
Social Desirability Awareness Diversity Equality Cultural/ social fit	Set clear purpose (social value) for challenge-led innovation Incentivise multi-sector collaboration to common problems across sectors/regions Connect end-users to innovators through engaging regional and local networks, third sector, community groups and crowd sourcing platforms. Widen participation and co-design in innovation to traditionally underrepresented groups	The dedicated roles and leadership required for diffusion and adoption Areas suitable for "sandbox" regulation, where benefits of innovation outweigh risks of individual failures.
Technological Effectiveness/ advantage Reliability Simplicity, good design Compatibility Sustainability/ longevity	De-risk adoption by further developing and supporting common standards for interoperability and open architectures. Evolve IP rules to recognise service as well as product based innovation. Reduce barriers for innovators accessing independent technical expertise	Channels for diffusion/adoptions of tried-and-tested/COTS technologies from one sector into an adjacent sector Subsidised investment in innovative technology to reduce cost of entry

Source: PA

2.3.3 Dimension 1: Behavioural

Potential solutions to explore:

1. **Directly incentivising IDA-specific activity:** While there are strong incentives for inventors and initial innovators, there may be a role in incentivising those engaged in diffusion or promoting adoption – particularly in communities that face significant barriers. The people involved in innovation ideation, development, diffusion, and adoption have a variety of motivations, and reward-sharing mechanisms have the potential to accelerate IDA. These

incentives may be financial reward when an innovation reaches some set revenue (analogous to whistle-blower rewards in the US, or treasure-finders fees in the UK), through the Honours system or other system. There is further work to be done on the best incentives for promoting IDA behaviour and actors.

2. **Monitoring metrics focussed on IDA through a National IDA Survey:** Many of the factors that lead to greater IDA success are known, and there is potential to gather these metrics in order to better understand the area and learn how effective policy measures are. Because information is lacking in key areas, a new National Innovation and Diffusion Survey may be used to gather and evaluate relevant information at a national, organisational, regional and local level across different sectors. Such a survey can contribute to a system for measuring effectiveness of IDA and putting in place the resources to evaluate policy interventions, monitor progress and learn what works to adapt the current approach.

3. **Tackling information gaps through trusted networks:** Lack of information on innovations has been cited as a barrier to adoption across studied sectors. Government provision of impartial advice can go some way to filling this gap however different communities and sectors often rely on specific trusted networks for this input. Tapping into existing networks will allow this advice to diffuse across sectors more efficiently and reach communities that may not otherwise engage. Having the right information from trusted sources, and actively countering misinformation – whether through influencers, intermediaries, friends and family or other sources – can help innovations diffuse more successfully.

Identified areas for further research

1. **The potential role of a national or shared purpose in expediting IDA:** We have seen cases where aligning to a shared purpose such as sustainability, or responding to the COVID-19 pandemic has expedited the process of IDA for innovations such as electric vehicles and mRNA vaccines. As people look to innovation to address climate change, diversity and levelling up priorities there is further research needed on the potential impact alignment to shared values can have on attracting quality talent, interest and efficiency of IDA.

2. **Cognitive-bias and socio-cultural barriers:** Many of the barriers and success factors for IDA are socio-cultural, and cognitive biases can prevent good innovations from becoming diffused and adopted. While there is an understanding that overcoming bias, failing fast and continuous improvement behaviours are needed for IDA there is more work to be done to understand the exact socio-cultural and psychological barriers to unlocking this.
This is needed at the individual and organisation level, as well as in

ensuring leadership in organisations is able to drive innovation and cultivate collaboration.

2.2.4 Dimension 2: Economic

Potential Solutions to Explore:

1. **Increased public funding and support for scale ups:** influencing the market through direct grant funding is a lever under Government control and is highly effective in addressing one of the key barriers cited by start-ups and scale-up companies and stimulating innovation in strategically important technologies. IDA often requires multi-year investment in a stable funding cycle with strong Government support. However, there are gaps in scale-up funding that negatively impact on IDA. Funding from Innovate UK and UKRI is available to develop innovative ideas[140] but grant funding is not available for scaling up. The UK has introduced Innovation Loans[141], but these require a business to take a financial risk and may not be large enough to take an innovation through to market success. Private equity investors may provide funding but may be unwilling to take risks on untested innovations that still need iteration and market-testing. This leaves a funding gap that Government can potentially address by reallocating some R&D investment to focus on addressing the challenges to pull-through at scale. This could be through direct investment in promising businesses, taking equity, as the Government is doing through the Future Fund and National Security Strategic Investment Fund (NSSIF). There could be opportunity to also create a public National IDA Fund to invest in scaling up solutions for public benefit, with an option for members of the public to buy bonds in IDA efforts for specific sectors / technologies, with a pay-out if successful.

2. **Tax credits for diffusion/adoption activities (not just for R&D):** R&D subsidies such as tax credits have a positive impact on driving R&D but little or no impact on commercialisation[142]. Most investment has focused on fundamental research, with a gap in applied and higher TRL funding: this pushes behaviours towards more R&D rather than taking R&D through to higher TRL development, scale-up and pull-through, and leads to a cultural, institutional, funding and activities gap in innovation between ideation and diffusion. Giving tax breaks for activities focused on exploiting innovations, driving IDA, could help nudge businesses to focus more in this area. HM Treasury should explore the potential for this with DSIT.

140 https://apply-for-innovation-funding.service.gov.uk/competition/search

141 https://apply-for-innovation-funding.service.gov.uk/competition/1116/overview

142 Xielin, L., Langmei, Z., & Boxu, Y. (2021). Are government R&D incentives conducive to improving regional innovation efficiency? Science Research Management, 42(7), 50.

3. **Showcase UK innovation internationally (with grant funding to participate):** exports are a driver of prosperity, but it can be hard for small or early businesses to engage with exporting. Government already provides a lot of support for businesses looking to export including an open database of export opportunities, Department for International Trade (DIT) guidance and support from a dedicated team. However, Brexit has created uncertainties about the environment for global trade and the paperwork required, plus trade restrictions, can make this complicated for small businesses especially. DIT run events overseas and have also started doing virtual events as well. DIT could help showcase public innovations – for example developed through the National Innovation Fund – to international investors and customers (not only those who have paid to attend large trade shows), helping to broker deals through simple, standard contracts translated into multiple languages. Because small businesses do not often have spare cashflow to travel overseas or promote their innovation, DIT could provide small grants to participate in these showcase events and provide free translation services to aid communication.

Identified areas for further research

1. **Role of the Foreign direct investment (FDI) in IDA:** Some businesses rely on FDI to plug the funding gap for scale-ups and young businesses. In 2020 the UK was the 16th-largest recipient of global FDI flows (down five from the previous year), reaching USD 20bn in 2020, compared to USD $45bn in 2019 (-57%). 87% of megadeals (investments of at least £50m) included participation from a foreign investor, while 71% included participation from at least one US fund. In 2020, the stock of UK FDI was about USD 2.2 trillion. There have been concerns over the degree to which strategically-important technologies and products become subject to FDI – or direct buy-out – which cumulatively erodes the UK's knowledge assets. In early 2022, a new foreign investment regime began under the National Security and Investment Act 2021 requiring businesses and investors to submit notifications for certain acquisitions and investments in 17 sectors: however, this is not yet well understood and tested. Investment from some countries may be of more concern than from others. There is a need therefore to explore strategic management of FDI and its potential benefits or limitations for IDA. The outcome of such research, if combined with greater UK investment to plug the funding gap, may offer scaling businesses more choice in how they choose to grow.

2. **Impact of public sector buying power:** Exploring the impact of public sector buying power on IDA of innovations can be used to understand the untapped opportunities, shown in figure 9, for Government to do more in IDA by acting as first or 'anchor' customer. There is some evidence that giving a business a

boost as a big first (and repeat) customer can provide innovators with cash flow to reinvest in growth, and provide credibility and reputation in the marketplace, which can help further sales and exports. Further research through skunkworks – to take commercial off-the-shelf technologies (COTS) and create 'good enough' solutions that can be rolled out and improved over time. This would drive a faster pace of adoption and keep a rate of demand high – instead of buying once every decade, buying little and often works better for innovation adoption, allowing businesses the opportunity to constantly iterate and improve. Procurement cycles for innovation can be redesigned to allow injections of innovative technologies more frequently.

3. **Collaborative co-investment structures:** Siloed innovation means time and effort can be wasted reinventing ideas or developing products and services for which the market doesn't exist, and thus will not diffuse across a sector or be adopted. Developing an environment that promotes collaboration means it is more likely that better ideas emerge and are developed, diffused and adopted, with a higher profile and more road-testing among a wider and more diverse group of collaborators. Further research is needed on the implications and impact of financial vehicles in which businesses, universities and Government can co-invest in developing solutions together through co-creation, if combined with suitable standard IP and contractual arrangements made clear upfront, so that, should an idea become profitable, the collaborators benefit proportionately to their contribution.

4. **Increased access to publicly funded/subsidised business and marketing support:** innovation adoption depends on how aware people are of the new product/service/way of operating, and what the benefits for them are. Start-up and scale-up companies often do not have the budgets for branding and marketing activities, and no access to specialist skillsets in this area. They also need to develop themselves as businesses – from organisation design, processes and internal communications, and would benefit from knowledgeable support in how to scale up well. Government could provide direct support, or subsidised, free-to-use or credits for services in these areas on a call-off basis so that scale-up businesses can get support when they need it.

2.2.5 Dimension 3: Social

Potential solutions to explore

1. **Set clear purpose (social value) for challenge-led innovation:** Mission-orientated innovation can encourage innovations to become more quickly diffused and more widely adopted. It has often been noted that IDA can move quickly in a crisis – as with the COVID-19 pandemic. Though the rapid creation of vaccines against COVID-19 was the result of decades of public and private investment in related activity, the successful diffusion and adoption was reliant on a galvanised effort of multiple actors to ensure the spread and uptake. A way to ensure focus on IDA could be to set clear challenges to address, as part of the National IDA Fund, which can continue to inspire people to get involved and raise the profile of key innovations to aid IDA. This work could be led by the Cabinet Office Innovation Unit, supported by the Office for Science and Technology Strategy, to gather challenges; and prioritised across Government and delivered through Innovate UK.

2. **Incentivising multi-actor collaboration and taking a co-ordinated approach to solving common problems across sectors/regions:** Cross-sector fertilisation of innovation would help diffuse innovations more widely. Encouraging innovators to explore adjacent or even very different sectors could help develop and adapt existing solutions and technologies, shortening time to market. Where there are common benefits in developing specific technologies or innovations (such as data science, sensors, and behavioural sciences), the UK could take a national-level strategic approach to co-ordination through bodies such as Innovate UK. Sectors (and subsectors) can operate very differently and for different incentives and purposes, which do not always align. Sometimes it can seem much easier to not collaborate and create something new; this can lead to a fragmented and duplicative innovation landscape, hampering opportunities to focus on diffusion and adoption of innovation. Creating multidisciplinary cross sector 'skunkworks' teams where employees are seconded for time-bounded periods to work together on a specific targeted projects could be a method to enhance collaborative spaces to rapidly drive IDA. They provide the time, space, and facilities to develop IDA by addressing the multiple and interconnected barriers to IDA, enhancing collaboration and coordination and bringing together the right skillsets and knowledge for IDA.

3. **Connecting to end-users and tapping into regional and local networks, third sector, community groups:** Innovation adoption is also influenced by regional and local influences. Innovations can play out very differently in different local contexts. Having a better on-the-ground sense is important to spot challenges and engage people in adopting innovations. Forming and

utilising local networks can provide close customer engagement and greater interaction with end-users improving IDA opportunities. A potential solution could be creating more liaison roles dedicated to building these relationships which would help create capacity for end-user engagement, as it would encourage more operational end-users to get involved in co-creating solutions so that solutions are tailored to their needs and timescales. Opportunities for public trials, exploration and feedback could be explored by plugging into or connecting such networks with end-users. Though IP and other types of protection would need to be considered, there could be opportunity to use feedback from local networks and end-users to drive IDA appropriately designed for people and regions. Engagement could prevent, for example, distrust or lack of alignment (with beliefs, norms, cultural aspects and processes specific to regions) becoming a barrier to adoption, where early interaction and iteration could avoid problems later on.

4. **Widening participation and co-design in innovation to traditionally underrepresented groups:** There are many opportunities to engage a wider range of people and to ensure we are promoting diversity and inclusion in innovation at every stage – from creating and recruiting IDA roles (innovation teams, brokers, talent pools etc) through to end user and wider public engagement. At every stage, attention should be paid to inclusivity, widening the pool of participants, and reaching out proactively to invite diverse groups and individuals to get involved.

Identified gaps for further research

1. **Understand the dedicated roles and leadership required for diffusion and adoption:** Effective leadership can lead to improved IDA. Leaders set organisational goals and future strategies beyond ideation, and their attention drives activities that can enhance IDA opportunities. Leaders should see their role not only as innovating but also being responsible for IDA; this may require more coaching and training into specific skills. This could include skills such as creating and leveraging networks, seeking opportunities and forums to diffuse the innovation, as well as speaking the right language to communicate effectively to different audiences (i.e., investors and customers). More research is needed to understand the specific skills required for IDA. The UK is already investing in attracting global skills through the UK's start up visa system and Scale Up Visa to make it easier for fast-growing businesses to attract global talent. This could be utilised to support attracting the right talent for IDA.

2. **More research could be conducted to create and carve out experimentation spaces freed from normal regulatory constraint:** Having the appropriate regulatory environment is a key factor in IDA: most sectors

benefit from a light-touch, agile and responsive permissive regulatory environment to encourage innovation. Some regulators such as the FCA now have 'sandboxes' to help innovators explore[143]. Combined with the skunkworks concept, in these special experimental project teams, normal policy, regulatory and legislative rules can be suspended (under Government protection with carve-out exemptions from legislation such as on data-sharing) so that datasets can be created and used to develop and test ideas, in a suitable IP environment. Government would own the IP and people contributing to the development/diffusion receiving some payoff. This would permit rapid development without the uncertainties that come from not knowing whether or not you are allowed to be innovative, to a certain point of development where a decision can be made to switch off the work, or that it has demonstrated something worth taking forwards through handoffs to other parts of the organisation/ecosystem – in some cases taking it forward may mean legislative change to permit this.

2.2.6 Dimension 4: Technological

Potential solutions to explore

1. **De-risking technology by setting common standards for interoperability, open architectures could be further explored:** Innovations are more likely to be adopted where they are interoperable with existing technologies, operating systems, and hardware/software: Government can promote and if necessary enforce its best practice standards for data, manufacturing and operating that promote or mandate open architectures and systems so more people can innovate around them, with a greater chance of the innovation becoming adopted.

2. **IP rules that allow people to share ideas and early products, support for test/trial activities:** IP includes registering patents, trademarks, design, copyright, know-how and wider knowledge assets. It is important to manage the ownership and use of all types of IP up front in the collaboration. Some organisations exist to help spin out and license IP, such as Ploughshare and TTOs, but IP regimes can vary between organisations and take a long time to negotiate. For innovations likely to benefit the UK – for example those developed with Innovate UK funding – it may be preferable to have simple standard joint IP arrangements and standard commercialisation contracts to speed up innovation diffusion and facilitate collaborative partnership working. For example, in co-creation arrangements or where there is pooled investment in developing products and services.

143 Regulatory Sandbox. Retrieved 31 March 2022, from https://www.fca.org.uk/firms/innovation/regulatory-sandbox

3. **Improved access to experts/help to find the right technical, engineering and manufacturing advice:** solving some of the technology barriers to diffusion requires a multidisciplinary approach and access to a wide set of skills, from deep technical expertise through to engineering, manufacturing know-how and potentially software developers, systems engineers, supply chain specialists and a multitude of other skills and support services. These can be a blend of public sector organisations (such as Catapults and National Laboratories) and private sector consultancies and service-providers. These can be hard for a scale up business to discover and find funding for – one route is via Catapults, but these are not in all sectors or regions. An independent online 'trusted broker' or matchmaking service (not paid-for advertising by businesses) could help businesses looking to scale-up find, access and engage the right support services tailored to their specific requirements – especially if supported by specialist intermediaries/ brokers.

Identified areas for further research

1. **More research could be done to adapt tried-and-tested/COTS technologies from one sector into an adjacent sector, and how this process could be turned into mutually beneficial outcomes for IDA:** As well as cross-sector fertilisation of innovative ideas, Government can also identify and promote opportunities for cross-over of existing technologies from one sector to another, which could benefit from their approach: this could reduce time to market using COTS 'good enough' solutions.

2. **Subsidised investment in innovative technology to reduce cost of entry:** individual and organisational consumers (in the public, private and third sectors) could be encouraged to take up and adopt innovative products and services if the initial costs of purchase were reduced, perhaps through subsidies to promote innovations considered beneficial to society. This has occurred in some sectors such as health and energy (subsidised solar panels, for example) but often consumers have been left with heavy upfront or ongoing maintenance costs. Less directly, Government could ensure the infrastructure required to take advantage of innovations (such as e-vehicles and 5G) is widely available at low cost to consumers, reducing the barriers to entry for reluctant 'late majority' and 'laggard' consumers.

3 Next steps for UK diffusion and adoption

The UK's increasing R&D investment will not necessarily flow through into creating innovative products and services that will benefit the UK economically and socially, unless interventions are put in place to make it happen. Government has an opportunity to address this by better understanding and addressing the barriers to IDA. It can start by identifying priorities and challenges, setting out roadmaps with clear direction, using its buying power as anchor customers, and creating the right funding and regulatory environment to enable innovation to thrive. At the same time the UK economy as a whole would benefit from taking a supply chain approach to innovation, rewarding collaboration at all levels and across sectors, broadening the diversity of participation and recognising service-based as well as product-based innovation. Against this background there are some broad themes that can be explored:

3.1 Opportunities to understand and improve IDA

3.1.1 Identify the challenges and priorities needed to solve and inspire people to come together to address them in an open and inclusive way, giving them the freedom to experiment – with Government taking more of the lead by setting concrete direction

Government can set out inspiring national-level innovation challenges, and bring together diverse, multidisciplinary teams to rapidly solve them such as demonstrated successfully by the Vaccines Task Force during the COVID-19 Pandemic. Tapping into this sense of national purpose, to solve a particular challenge or problem-set, inspires people to come and work on solving the challenges, focuses efforts and reduces the barriers to IDA. When the purpose is linked to shared values, such as social change, a broader cross-section of people from different sectors (public, private and third sectors) are more likely to work well together to create and share innovative ideas.

Innovation needs dedicated time and effort – from ideation to diffusion to adoption. This cannot be done effectively by people distracted by their day-jobs and other priorities. Government can create 'skunkworks'-type operating models and facilities where people can be seconded to focus on solving time-limited problems or challenges and rapidly driving IDA. These teams would be diverse, multidisciplinary, open to challenge, highly engaged with end-users/customers and embed the right

culture and mindsets. The roles should be well remunerated, and prestigious, to attract the best talent and provide the support they need to progress rapidly.

Because many big challenges are complex and need participation from a variety of sectors, co-creation models should bring together Government, industry and academia to co-develop solutions and drive them through diffusion to adoption – these could be physical places, virtual networks and online collaboration spaces, or a hybrid approach. An agile sprint approach should be used, leading rapidly to demonstrations of value, trials and showcasing progress. A gated approach should be taken to switch projects on/off and to move things forward to trials, including for some innovations holding open public trials to invite challenge, build support and address any concerns.

To give these experimentation spaces and groups the freedom to explore new ideas, Government could carve out exemptions from legal and regulatory constraints (excepting health and safety), with appropriate oversight, transparency and governance. A cross-Government Board would oversee these skunkworks, with the power to provide additional as-needed exemptions guided by legal and ethical advisers and public representation. The creation of these ways of working could be the purpose and USP for the Government's new Advanced Research and Invention Agency (ARIA). Government needs to take the lead by setting concrete direction to help innovation succeed.

3.1.2 Invest in skills and drive collaboration at all levels, including leadership and skills development

IDA is a team sport: no individual or group can make them happen alone. That means improving collaboration across the innovation ecosystem. Collaborative behaviours and practices take time to develop and some are better at this than others. Dedicated training, coaching and career recognition is needed, incentivising people to develop and sustain effective collaborative relationships at all levels. Leaders can be trained to prioritise and promote IDA, empower their teams to take risks, and create a culture of learning and continuous improvement.

Creating dedicated roles for collaboration to drive IDA activities would help create the right professional expertise and skills: these 'brokers' will need a mix of technical understanding with an ability to 'translate' and could be good roles for post-doctoral students not looking to pursue purely academic careers. Accessing the right skills at the right time could also be aided by creating pools of specialist staff who can be drawn upon as needed, through a secondments programme that allows talent to be shared more easily between Government, industry and academia – and by making this kind of broadening of experience both routine and valued in career pathways. Talent is found globally, and the UK will need both long-term skills programmes in schools and universities to teach innovation, risk assessment, entrepreneurialism,

and collaboration, and to attract and retain international talent. Getting more people engaged in innovation in this way could help aid innovation diffusion and reduce resistance to change.

Collaborations can be hindered by IP practices and rules that prioritise invention (coming up with the idea) over the equally vital contributions of those who develop, spread, and adopt the idea. Simple, standard IP and contract arrangements for collaborative working across organisations and between sectors would encourage and facilitate effective formal and informal partnership working. These should cover all phases of development, testing, trialling and diffusion, through to procurement.

3.1.3 Broaden the diversity of participation and perspectives, and build trust

Diversity is key for creating the innovations that people want, that will work for them. It is essential to widen participation in innovation activities and diversify the ecosystem, by creating opportunities for a range of people from different backgrounds and experiences to become engaged in innovation. Equality, diversity and inclusion should be a core component of innovation policies and practices – from co-designing initiatives and targeting under-represented groups to amplify their voices and experiences, through to finding ways to routinely and proactively seek alternative perspectives, challenge groupthink and increase understanding of how different people from different backgrounds may perceive and respond to specific innovations.

People can operate under a variety of cognitive biases. Making use of social and behavioural science and psychology insights can address some of these psychological barriers and encourage people to make beneficial changes – such as changing lifestyles to become more environmentally sustainable or making positive health interventions. Understanding which are the trusted sources of information helps create messages which will be listened to; as will countering misinformation, and using various techniques to identify cognitive bias.

3.1.4 A more joined-up ‘supply chain’ approach to diffusion and adoption, with cross-sector fertilisation of ideas and technologies, and place-based specialisms creating ‘hubs’

The innovation ecosystem in the UK is very fragmented and mostly not focused on IDA activities. A supply chain approach, where different parts of the ecosystem play clear roles, with handoffs between them and a focus on achieving value at scale would be beneficial. There are untapped resources regionally, in local communities and in the third sector, which can play key roles in IDA, and more should be done to leverage these resources and skills for national benefits. Many sectors have common problem sets and it is necessary to take a more co-ordinated approach to solving these common problems together, including developing cross-sector

networks to raise awareness/exposure to how others have solved problems, and adapting tried-and-tested/COTS technologies from one sector into other sectors.

3.1.5 Funding and shared investment in diffusion and adoption activities, improving public sector procurement with multi-year funding for innovations meeting the national purpose

Funding to transition from early adoption to early majority is difficult to source and where it fits within national challenges could be better supported through a portion of Government R&D spend. A new public National Innovation Fund could be created to crowdsource investment in scaling-up solutions for public benefit, so people can invest and be rewarded when innovations become successfully adopted. Other funding mechanisms can also be explored, including creating a financial vehicle for companies and universities to pool/co-invest in developing solutions together (perhaps through or with private equity investors), and broadening R&D tax credits to cover innovation diffusion/adoption activities. The benefits of inward investment and funding via FDI needs to be balanced against the longer-term interests of the UK in maintain strategic skills, expertise and ownership in key areas, and this needs a more strategic, cross-Government approach to build on the legislative tools and move upstream in getting buy-in and influence. Exports are a driver of IDA internationally, and the UK could do more to help showcase UK innovation internationally – including providing grant funding to participants.

Government commercial and procurement processes are not optimal for IDA, even though Government could play a direct role in IDA by acting as anchor customers so public buying power drives the adoption of great innovations. The public sector would benefit by embracing ‘good enough’ innovative products and services and investing time to demonstrate and improve these at scale. Innovation activities need long-term sustained funding in a predictable funding environment, with multi-year spending commitments that enable longer-term contracts and partnerships. The restrictions on R&D spend need to be loosened to cover higher TRL, diffusion and adoption activities. Government also needs to create commercial models for rapid end-to-end innovation (from idea to buying a product at scale) and reshape public procurement activities to prioritise innovation over risk-aversion. Refreshing Innovation Partnerships under PPR2015, upskilling commercial officers to use these models, and potentially creating a bespoke innovation commercial team in Government to support these kinds of activities could help unblock some of the key barriers.

3.1.6 Targeted support for diffusion and adoption activities, including better metrics

As well as funding for IDA, there needs to be wraparound support that addresses the various dimensions needed for successful IDA: including technology, social and behavioural factors. There should be access to publicly funded/subsidised business and marketing support to grow businesses effectively, and communicate and spread great innovations more widely. Scale-up businesses need to access the right experts quickly, and need help to find the right technical, engineering and manufacturing advice and support for test/trial activities. In addition, IDA should be seen as a specialist and multidisciplinary set of skills that need specialised and dedicated IDA roles, training and skills development. Incentives should be created to drive IDA success, including financial rewards and other kinds of recognition. This needs to be backed by better information and data on ‘what works’ and how different sectors are affected – including national, regional and local metrics, and systematic evaluation – set out in an annual report monitoring progress and sharing best practice.

Methodology and acknowledgements

For this report, PA Consulting received and reviewed a range of inputs: a systematic literature review and meta-analysis of over 150 research papers, white papers and books; interviews and input from almost 100 innovation experts; additional commentary from a roundtable event; and additional data gleamed from a proprietary research survey of over 500 innovation leaders.

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