INNOVATION & RESEARCH CAUCUS

INNOVATION ADOPTION AND DIFFUSION FRAMEWORK:

Summary Guidance

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INTRODUCTION

This document is designed to accompany the full report, **Lessons from the History of Technology Adoption and Diffusion**[1], which uses a set of frameworks to distil lessons from evolutionary journeys of three different technology families to facilitate adoption and diffusion today and in the future.

Adoption and diffusion have come to occupy a central role in innovation policy discussions and there is no shortage of models. The frameworks introduced here were developed by the Innovation and Research Caucus in partnership with the Horizon Scanning team at Innovate UK as a tool to enable policy makers and those who design policy interventions to more effectively support the adoption and diffusion of innovations and technologies of the future.

This 'How To' guide provides guidance for users on use of the Adoption and Diffusion Frameworks to gain insights and better design adoption and diffusion interventions.

Background

The adoption and diffusion of technologies and innovation play crucial roles in driving economic growth and societal transformation[2]. However, the diffusion of technologies across industries, regions or countries has historically been uneven.

Society is experiencing paradigm-shifting opportunities and challenges from rapid technological advancements in, for example, digital/AI, robotics, and bioengineering. Maximising the economic, societal and environmental benefits of emerging technologies, adequately manage the risks, and do so responsibly, requires the widespread adoption and diffusion of beneficial applications of technology across businesses and society.

1 Nelles, J., Salihu, H., Tuckerman, L. & Vorley, T. Nov 2024. *Lessons from the history of technology adoption and diffusion*. Oxford, UK: Innovation and Research Caucus.

2 Rodríguez-Pose, A. (1999). Innovation prone and innovation averse societies: Economic performance in Europe. *Growth and change*, 30(1), 75-105.

WHAT ARE THE FRAMEWORKS FOR

The frameworks were designed to be a tool to help policy makers and programme designers develop an understanding of what kinds of barriers might exist to getting specific technologies to spread from early adopters to a wider community, and how public stakeholders might intervene to reduce constraints and multiply opportunities for adoption.

The adoption and diffusion frameworks are both designed around a series of questions that can be used either directly with target communities or to help structure programmes (to guide desk research.

We specifically focus on how policy and interventions can support the diffusion of innovations to the critical point in technological development where they become widely adopted (see Figure 1).

There is role for policy actors in affecting both the diffusion and adoption of innovations and it is likely that targeted interventions can help individual firms or classes of firm become more receptive to innovation.

However, there is no one answer that is appropriate to every firm, industry, or context. Different factors will affect businesses, and their innovation adoption decisions, differently. As the structure of the adoption framework demonstrates especially, adoption decisions are complicated and can be impacted at different stages. That is why it is crucial to understand the specific context of the target business, group of businesses, or industry and where in the decision-making process to intervene (and how). These frameworks are specifically designed to develop that understanding to enable more precise and effective interventions.

How these frameworks sit relative to other adoption and diffusion projects

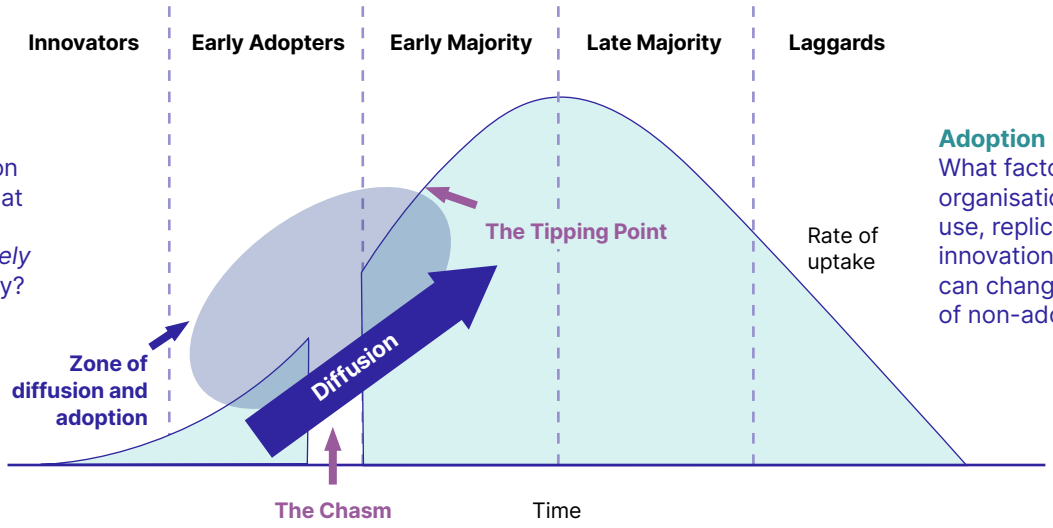
Unlike most existing approaches, this guidance consists of two frameworks instead of one. One focuses on the challenges regarding adoption, and the other focuses on the specific challenges of diffusion.

This dual framework approach provides insight into the largely internal decision-making processes of businesses (adoption) as well as highlighting how *external* factors such as whether information about the potential of innovation is reaching target communities, the messages they may be receiving, and the quality of the information upon which subsequent adoption decisions will rest (diffusion).

While there is space for public intervention to shape both the internal decision processes of firms and dissemination of information about innovation, the latter is often overlooked in alternative frameworks.

The big questions

Diffusion
How does information about innovations that have been adopted disseminate *effectively* through the economy?



Adoption
What factors influence organisations' decision to use, replicate, or adapt innovations? What factors can change behaviour of non-adopters?

Figure 1: The diffusion challenge: Focusing on accelerating diffusion beyond early adopters (Adapted from DSIT, 2023)

DEFINITIONS

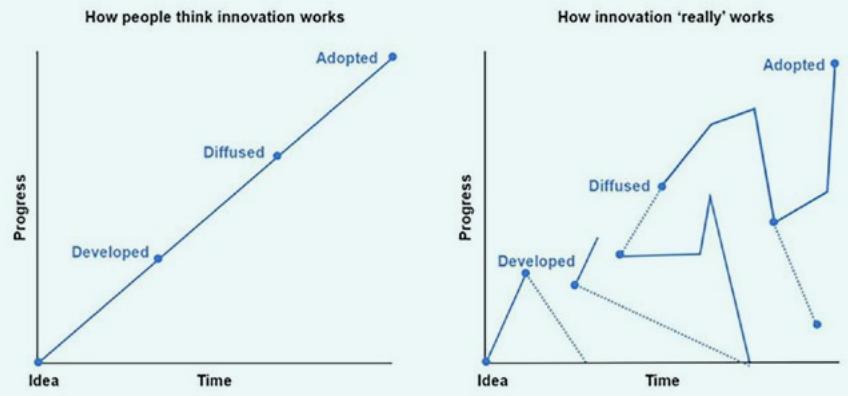
Technology adoption refers to individual or organisational decisions to use or implement the technology. Adoption can be described as 'the implementation and assimilation of an innovation within an organization'[2]. The study of technology adoption, therefore, focuses on what affects the decisions of principals within businesses to use specific innovations.

Technology diffusion refers to the spread of technology through economies. We define it as **the spread of something within a social system**. The key term here is '**spread**': the flow from a source to an **adopter via communication and influence**[3]. Diffusion focuses on the social and systemic spread of ideas, innovations, or technologies – tracking the speed of transmission and characteristics of populations through which certain ideas travel and are implemented more quickly[4].

Related to diffusion, *dissemination* describes the **mechanisms** through which knowledge of and exposure to innovations occurs.

Adoption and diffusion are closely related concepts in that diffusion is typically measured in terms of rates of adoption. The process of diffusion is rarely linear or straightforward (see Figure 2). Furthermore, decisions around adoption differ from business to business, from industry to industry, and innovation system to innovation system etc.

Diffusion is typically considered at a high level – a technology spreading through an economy. And as a result, some nuance can be lost. The assumption often is that more is better. But a myopic focus on 'more' may risk exacerbating inequalities or externalities that cascade through the system. By considering technology diffusion in the context of broader policy priorities and thinking critically about lessons and consequences from the past, policymakers can encourage more considered and effective adoption.



Note that this diagram positions diffusion before adoption along the time axis. This recognises that while diffusion is a function of adoption and that they are nearly simultaneous. The gradual accretion of individual adoptions provides signals to other potential adopters. Therefore, as technologies diffuse, they precede the next wave of adoptions.

Figure 2: Differences between perception and reality of how adoption and diffusion work (DSIT 2023)

2 Bui, Q. (2015). A review of innovation diffusion theories and mechanisms. DIGIT 2015 Proceeding. Lewis, L. K., & Seibold, D. R. (1993). Innovation modification during intraorganizational adoption. *Academy of Management Review*, 18(2), 322-354

3 Strang, D., & Soule, S. A. (1998). Diffusion in organizations and social movements: From hybrid corn to poison pills. *Annual review of sociology*, 24(1), 265-290

4 Rogers, E. M. 2003. Diffusion of Innovations (5th Edition). New York: Free Press. Valente, T. W. (2005). Network models and methods for studying the diffusion of innovations. Models and methods in social network analysis, 28, 98-116. Strang, D., & Soule, S. A. (1998). Diffusion in organizations and social movements: From hybrid corn to poison pills. *Annual review of sociology*, 24(1), 265-290

USING THE FRAMEWORKS

Both frameworks were designed to be used primarily as tools of inquiry. They are structured as a series of questions that will lead the inquirer to a greater understanding of the specific barriers to adoption and diffusion from which appropriate interventions can be derived.

1. Identify the target community and timeframe – the more specific the better.

These frameworks work best when they are being used to learn about patterns of adoption and diffusion in a narrower community such as within specific industries, types of firms, or companies, on specific innovations – or even specific applications of innovations, and specific places. Narrowing the target community down is important to get useful results.

For instance, this framework can be used to explore AI adoption among firms globally, but results will be informed by experiences in different cultural, regulatory, institutional contexts, etc. A more targeted strategy would focus on the adoption of AI for accounting (a specific application of an innovation), in SMEs (a specific type of firm), in the automotive industry (a specific industry), in the UK (a specific place). The narrower the focus, the richer and more comparable results are likely to be.

2. Determine what sources will be most valuable. Primary sources are the gold standard.

As the frameworks are based on questions, it is important to first determine the appropriate sources to answer them. This will depend on the time period, location, and feasibility (including your timeline restraints).

Interviews with relevant experts, supplemented with desk research, is the best approach but can be resource intensive. Workshops, surveys, and other means of gathering insight from experts could also be considered.

When using an interview-based technique, you will need to make sure you are sampling appropriately and be mindful that you are making judgements about who to approach and how many discussions to have. Think carefully about which organisations you approach, and who in the organisation will have the right level of experience and responsibility for adoption decision making.

Different types of research such as industry or network analysis may be helpful for answering some questions in the diffusion framework.

The ideal approach is to sample until saturation: to talk to many different individuals until you are no longer getting new answers or perspectives. How many interviews will be required to get to that point will vary by target community (some will be larger than others). Unfortunately, achieving saturation might not be possible within the timelines of your project. In those cases, it is important to acknowledge the potential gaps in results and draw conclusions with caution.

Obviously, in some instances, such as for historic case studies in the distant past, interviews are not possible. In those cases, desk top approaches are your only resource, so answers need to be reconstructed through a review of the literature.

3. Ask the questions and record results – use the frameworks as interview guides.

As the frameworks are built around questions, they can be treated as interview guides. Interviewees may not be able to answer every question and that some questions will not be applicable to all contexts. That's ok! It may be useful to draw on background research to contextualise questions or add in prompts that will encourage interviewees to consider other points of view and add details.

Re-phrase the questions to suit the circumstances. For instance, the question currently phrased

as '*do relevant actors*[5] *understand and accept the value of innovation to the business*' should potentially be rephrased to focus on firm leadership or R&D department heads or something else that is more reflective of the specific context of the firm. Questions like '*can the business afford to adopt the innovation*' should be rephrased to '*to what extend do businesses struggle with affordability of adopting [the specific innovation]*' for interviewees that are not members of a business.

There are many possible ways to record results, but it can be useful to adopt the table structure of the framework and record observations in relevant cells. Note that some cells will have no results or will have been determined by the investigation to be not very important. Some cells will be important to certain respondents and not others. It is ok if results seem unbalanced and only a few cells emerge as important. Be sure to record not only the constraints to adoption of diffusion but also those factors that emerge as opportunities or catalysts.

Also, do not feel limited by the framework. It is meant as a starting point for discussion and inquiry but if it has not anticipated a factor that is significant in your case, consider adding it to the framework for future reference.

4. Interpret the results. Consider systems approaches to explore relationships between different factors.

Once all the results have been recorded you can analyse what has emerged as most important and influential. Be sure to pull out positive as well as negative impacts.

The cells with the most results are likely to show the most important constraints (or opportunities) to adoption or diffusion. These will be the areas where interventions might be designed to overcome issues or leverage opportunities.

However, an important aspect of interpretation is understanding the relationship of these factors to each other. Often, factors within the table are interrelated and interesting insights can reveal themselves by exploring systemic interactions rather than treating them like a laundry list of items to tackle independently.

5. Devise interventions. Focus on understanding what levers could have most impact and who controls these.

An important step in designing interventions to encourage adoption and ease diffusion is determining who controls the policy levers most likely to have an impact. In some cases, remedies may be solely within the control of the adopting firm. But **in most cases, there is likely a role for public policy** in helping firms to overcome barriers and in facilitating effective information dissemination. Sometimes, this will require public actors to coordinate responses with other stakeholders or to seek out partners in other branches of government. But even if public actors do not have a grasp on all the required policy levers, there are often ways to design approaches to influence those that do.

The specific design of interventions will, of course, vary by context and in response to findings. However, there are some useful rules of thumb to keep in mind:

- First, not all pinch points are created equally. While the findings recorded in the table may give more visual weight to some cells, and hence some solutions, this does not mean that interventions are likely to have the same impact. After listing relevant barriers (or opportunities) make sure you reflect on which ones are likely to have the most impact on the desired objectives if addressed. If you need to choose just one thing to tackle, then intervention in areas that are more likely to produce results will be most effective
- Secondly, and in the same spirit, if several constraints are evident, then acting on one alone may not be enough for meaningful impact. Adoption and diffusion issues in one area will often not be resolved if you solve issues in another. Adopting a systems view of constraints can be helpful to understanding interrelationships. As such, keep in mind that it is sometimes most effective to design interventions in parallel than in sequence.

5 The term 'relevant actors' is used here as a placeholder and who those individuals are in any given business is up to the judgement of the interviewer. Typically, these include business leadership, but it can also apply to others within the organisation that can influence adoption decisions (e.g., department heads or workers who will have to implement the innovation).

FRAMEWORK IN ACTION:
ADVANCED MATERIALS AND MANUFACTURING (PRESENT – INDUSTRIAL AUTOMATION AND ROBOTICS)

In this section, we outline how we applied the framework to a specific case study using the process recommended in the previous pages. The resulting case study is available in the report.

1. Identify the target community and timeframe

For this study we needed to learn about the experience of a wide range of manufacturing businesses in the UK. As a result, we cast a relatively wide net and solicited input from multiple types of actors. We recommend that future research adopt a narrower focus to enable deeper interrogation of target communities. For instance, focus on specific types of manufacturing, firm sizes, firm ages, or business models. We defined the timeframe based on our initial literature review of different generations of industrial robotics development, which identifies the early 2000s as the advent of the present period of robotics development. Arguably, we are currently in a transition period as AI and Industry 5.0 is beginning to have a more tangible impact on businesses.

2. Determine what sources will be most valuable

We undertook this work as part of a larger project which included 9 case studies, and therefore were limited by both time and resource. Consequently, we relied primarily on secondary sources. We undertook a desktop review of reports from journals, industry news sources, and popular scientific press. We did have some resource for primary research and were able to conduct interviews with 4 people from policy, industry associations, and business. Full saturation was not possible due to the scope of the study and resource constraints, however by combining desktop and interviews this case study was conducted at levels near to gold standard. We used the framework table to record findings from our review of secondary sources. This helped to highlight questions (cells) where there were gaps or contradictions in our sources and provided some background info on the topic to inform follow up questions.

3. Ask the questions and record results

Because we had limited access to businesses and had to rely on primary testimony from policy and industry stakeholders, we did not have a good sense of diffusion issues. To get deeper at those questions we would have to speak more closely with businesses themselves, leaders and employees within them, and interrogate their information gathering processes. As such, the balance of our attention was on adoption trajectories. In this context, we focused more on questions of production and external conditions affecting industry trends. However, we worked through the entire topic guide with each interviewee in conversations that lasted between 60-90 minutes. As above, we collected observations from each interview in the appropriate table cell along with the results of the secondary source review so that it functioned as an evolving evidence base. Note that this method worked for our study, which was intended to provide an overview of a large industry. We recommend that more focused projects aiming for higher industry interaction might consider translating the questions from the framework into a word document allowing for more space to document and organise answers from a larger group of interview subjects. Researchers might also consider recording and transcribing interviews for more detailed future analysis.

4. Interpret the results

This step is about considering findings in context and understanding relationships between them. As seen in the case study in the report, we ensured that we extracted both positive and negative factors and summarised how some factors have implications for others. For instance, the issues related to labour flexibility (workforce) and demand (external) often work together to impact adoption considerations. Being vigilant to how decision makers bundle perspectives across categories can reveal dynamics that are not always evident when considering factors in isolation.

5. Devise interventions

The case study highlighted a number of findings that each suggested potential pathways for intervention. In one example, we explored the degree is the innovation compatible with typical ways of working and the extent to which the innovation provided an appropriate solution to and fit with the tasks of the production process.

Our findings suggest that the public sector should interrogate its assumptions about the suitability of industrial automation and robotics and adjust narratives and/or target communities accordingly. For instance, proceeding on the assumption that adopting robotics is definitionally good for every business will not be effective if that vision is not shared by the businesses themselves.

At minimum, some more diagnosis is needed about whether businesses are resistant because they *do not perceive* a benefit or *because the technology is not yet appropriate* for their context and/or practices.

The former represents an information asymmetry – appropriate technology exists but the businesses are not aware of it, or they are aware of it, but it is not accessible. Here, there is a potential role for the public sector in closing information gaps and/or rendering technologies more accessible.

In the latter case, despite the increasing proliferation of robotics, no technology appropriate for the business currently exists. This may be because the technology is not compatible with production processes or because the business has bespoke needs for which there is no effective automated solution.

In both cases, there is potentially a public role. First, in understanding the aspects of the production process that are not compatible with automation and exploring changes that might lead to opportunities for experimentation. Secondly, in understanding what kind of technologies might fill that need and investigating whether it might be possible, and worthwhile, to develop compatible technologies.

THE ADOPTION FRAMEWORK

	Willingness Openness to considering new innovations	**Capability** Ability to implement the innovation	**Capacity** Ease with which resources can be dedicated to innovation adoption
Workforce Related to worker willingness, capability and capacity	**Worker openness to new innovations** To what degree are employees open to the innovation/ technology within the firm? This may be influenced by perceptions of impacts on ways of working, changing roles, or identity that are specific to the technology or there may be more generalised resistance to change (e.g., 'not invented here syndrome') To what degree is behavioural change required from the workforce overtime (and what type) and how likely are workers to accept changes? Are there any cultural barriers at play related to communities of practice or sectoral norms?	**Worker skills** Do workers have the appropriate skills to implement the innovation? Do they have access to skills training/retraining required to drive implementation? Can an appropriately skilled workforce be accessed and/or trained?	**Worker capacity and alignment** Are workers appropriately matched with implementation roles? Is there sufficient flexibility in the workforce to enable implementation without adversely affecting production targets?
Management/ firm structure Related to management cultures, outlooks and firm resources	**Management awareness of innovative solutions** Are relevant actors within the organisation aware of innovations through networks or other means? Do relevant actors understand and accept of value of innovation to the business? Innovation alignment with business strategy and ambition How do innovations and their adoption align with the personal ambitions of the business leaders? Do leaders see the alignment of innovation with values and vision of the company? Does the innovation align with risk tolerance profiles? **Board and/or shareholder influence on innovation adoption** To what extent are governance structures supportive of technology adoption?	**Acceptability of costs** Can the business shoulder the costs of adopting the technology? Costs include both financial outlays related to purchasing the technology, supportive equipment, developing skills, and other costs on implementation. **Accessibility of resources** Do business leaders know about and have access to innovation implementation support resources? **Alignment of management skills with implementation demands** Do business leaders have relevant skills to manage innovation implementation? **Existence of structures/ processes to facilitate change** Are there processes in place to facilitate change management? Do hierarchies or organisation configurations create barriers to implementation? To what degree do working arrangements/management structures support change?	**Appropriateness of return on investment** Are investments in implementation likely to generate an acceptable return over time? **Adaptability of management and firm structures** Are appropriate resources available within sufficient time frames to enable implementation? What are the opportunity costs of devoting management attention to implementation?

	Willingness Openness to considering new innovations	**Capability** Ability to implement the innovation	**Capacity** Ease with which resources can be dedicated to innovation adoption
Production Related to integration and compatibility with existing production processes	**Alignment of innovation with production processes and ways of working** To what degree is the innovation compatible with typical ways of working? To what extent does the innovation provide an appropriate solution to and fit with tasks in the production process?	**Production constraints** Are there technological or resource constraints to integrating innovation production processes? (e.g., access to related supply chains) Are there environmental constraints (e.g., lack of access to power or infrastructure) to adopting innovation into production?	**Expectations of resilience in the face of system downtime** Can production systems accommodate downtime to incorporate innovation while maintaining output to meet demand? What are the (opportunity) costs associated with integration of innovation in production processes (includes time, retooling, etc)? What kinds of system effects are anticipated or likely beyond the immediate implementation of the technology and how are these expected to influence business outcomes?
External context Related to customers, markets, and other conditions external to the business	**Attitudes and demands of customers and markets** To what degree are customers/ downstream markets demanding innovation that might require adopting new approaches? How will adopting the innovation affect business reputation and influence? **Influence of regulations** To what degree does the regulatory environment appear to be likely to support adoption of this innovation over the long term? How consistent or clear is regulation that might influence adoption decisions? **Market inducements** What is happening in the markets for alternatives or substitutes (e.g., exogenous impacts on price or reliability of supply etc. of alternative products)? Have external events affected the urgency to develop and distribute the innovation or created market opportunities? What types of events might impact this and how likely are they? **Competitive pressures and norms** To what degree are competitors adopting technologies or have advantages that may drive the business to seek technological solutions? Are there any industry standards, cultures, norms or practices that may influence businesses to seek technological solutions or avoid doing so?	**Access to appropriateness of support resources** Are there external incentives or resources to assist with adoption? **Appropriateness and reliability of infrastructure and supply chains** What kinds of external/market developments are necessary to make adoption feasible (e.g., infrastructure, scale of markets for inputs, etc?) Is access to the technology likely to be reliable?	**Anticipated impacts on existing production lines and pipelines** To what degree will innovation adoption enhance or detract from customer/market demand (e.g., subtract resources from crucial/core revenue streams)? Will technology adoption affect other pipelines of innovation support that sustain the business (e.g., tax credits)?

THE DIFFUSION FRAMEWORK

	B2B partnerships	Intermediaries	Social networks
Relative advantage Does the way the innovation is framed make a clear case that it is better than the idea it supersedes?	Does the specific pitch take into account the interests, values, positionality, needs, and constraints of the potential adopter? To what degree has feedback and iteration shaped innovation framing?	Is the pitch aimed at an appropriate audience and relevant to a variety of circumstances (e.g. anticipating and acknowledging differences) enabling technology to transcend barriers? Are benefits being described in ways that enable them to be successfully reproduced in other contexts? Are there specific rules and regulations that encourage exploration of the innovation in question and are intermediaries effectively communicating these incentives?	How are early adopters (firms, but also of specific groups, e.g., labour, management, etc) discussing the innovation? To what extent are downstream and social reactions positive? To what degree are competitive pressures being transmitted through networks (e.g., FOMO)?
Complexity Is the innovation framed in terms that are widely understandable to maximise accessibility?	How effectively has the simplicity of change and its implementation been communicated? If adaptation is required, to what degree is this evident and mitigated in sales and marketing pitches?	To what degree are there adoption support services and mechanisms to reduce appearances and effects of implementation complexity? To what degree does communication by intermediaries about the technology and support take into account differences either between firms or between industries?	Is the innovation applicable and appealing across sectoral boundaries? Is there a potential for relatedness? To what extent does the complexity of adoption shape framing (positive or negative) about the innovation? Do narratives discuss ideas, behaviours, etc have to change in order to adopt the innovation? Do any of these factors vary by audience type? If so, how?
Observability Are the results of adopting the innovation visible to others (and regarded as credible)?	To what degree are technology providers able to share evidence of adoption success with potential clients? Do positive examples cover a range of circumstances such that potential adopters can translate those experiences to their own contexts? To what degree are accounts of successful adoption seen as credible?"	How are examples of success being communicated to target communities? Are they being communicated to the right stakeholders (e.g., not just firms but to the right people within them)? Are acheivements within intermediaries' communities being celebrated and shared? What role do change champions/ peer leadership play in efforts to spread innovation?	How fast and visible is uptake by peers? How do network characteristics and number of channels affect spread? - geography, proximity, frequency of interactions, degree of proximity between champions and potential adopters To what degree are peers visibly demonstrating/ communicating outcomes? To what degree is information regarding the innovation and its implementation available and effective for those that seek it independently? (How is it codeified, by whom, and for what purposes?) To what degree is information about the innovation being disseminated by respected peers, champions, or change agents?
Trialability To what degree can the innovation be adopted on a limited or trial basis (this refers to both opportunity and suitability) or seen in action?	To what degree can the innovation be demonstrated and trialed through the partnership?	Are there accessible, publicised trial and demonstration projects that show the innovation in action? Are potential adopters able to experiment with the innovation without fully adopting?	Do peer networks permit exposure to innovation in action (e.g., peers sharing access and experience)?

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About the Innovation and Research Caucus

The IRC supports the use of robust evidence and insights in UKRI's strategies and investments, as well as undertaking a co-produced programme of research. Our members are leading academics from across the social sciences, other disciplines and sectors, who are engaged in different aspects of innovation and research system. We connect academic experts, UKRI, IUK and the ESRC, by providing research insights to inform policy and practice. Professor Tim Vorley and Professor Stephen Roper are Co-Directors. The IRC is funded by UKRI via the ESRC and IUK, grant number ES/X010759/1. The support of the funders is acknowledged. The views expressed in this piece are those of the authors and do not necessarily represent those of the funders.

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