Innovation intermediation in supply networks: Addressing shortfalls in buyer and supplier capabilities for collaborative innovation

Abstract

We investigate how innovation intermediaries address shortfalls in the capabilities that buyers and suppliers must have to access each other's knowledge for innovation purposes, also referred to as indirect capabilities. Prior research on supplier-enabled innovation has identified various capabilities that buyers need in order to collaborate with innovative suppliers. It recognizes that suppliers also require capabilities to access buyer knowledge. However, we still know little about the role of innovation intermediaries – actors who are neither buyers nor suppliers, but still influence innovation processes and outcomes in supply networks. Our case-based research shows that intermediaries create workspaces for R&D and experimentation, help to refine definitions of requirements and de-risk novel solutions, support contracting, and facilitate solution implementation. We contribute to research on supplier innovation by developing a model of intermediaries' activities and underlying capabilities, and their impact on innovation sourcing outcomes. We elaborate the indirect capabilities theoretical perspective by introducing additional types of indirect capabilities for collaborative innovation in supply chains, and showing how these capabilities interrelate. We furthermore extend the literature on innovation intermediaries by elucidating hitherto unexplored capabilities for intermediation and adding insights regarding the contribution of intermediaries to open innovation processes.

Keywords: collaborative innovation; indirect capabilities; innovation intermediaries; supplier-enabled innovation; supply networks.

1. Introduction

Innovation is imperative for organizations seeking to create value and address contemporary challenges such as those related to sustainability and resilience (Bellamy et al., 2020; Yan et al., 2022). Organizations undertake innovation themselves, but also rely on the capabilities of counterparts in their supply network – defined as a network of customers and suppliers exchanging products, services, and information (Kumar et al., 2020). Suppliers are particularly

important sources of innovation, because they possess specialized knowledge and technological capabilities (Johnsen et al., 2022; Oke et al., 2013) that the focal organization does not have. Recent evidence shows that first-tier suppliers invest in R&D more than their OEM customers do (Kumar et al., 2020). Such supplier R&D investment contributes to improved financial performance of the focal firm (Dong et al., 2020).

Buying organizations influence supplier innovations through their sourcing and supply management practices, including supplier assessment and selection processes and incentives for collaboration (Kurpjuweit et al., 2021; Selviaridis, 2021; Villena & Dhanorkar, 2020). However, collaborative innovation can be difficult, for buyers and suppliers alike (Selviaridis & Spring, 2022; Uyarra et al., 2014; Van Echtelt et al., 2008). For instance, buyers can be limited in their ability to articulate their (future) needs and requirements in a way that fosters supplier creativity, or to design contracts conducive to supplier-led innovation. Suppliers, on the other hand, may be ill-equipped to engage with the buying organization to understand its actual needs and problems, or to test novel solutions to ensure these fit the buyer's operating context. Many of these difficulties stem from capability[1] shortfalls within both buyer and supplier organizations (Flowers, 2007; Spring & Araujo, 2014; Zaremba et al., 2017).

Innovation intermediaries, broadly defined as organizations operating at the demand-supply interface and supporting the innovation process (Howells, 2006), can help buyers and suppliers in overcoming their capability limitations. Innovation intermediaries assume an increasingly important role in supply networks. A notable example in the UK is the Innovation Gateway (2023), an intermediary focusing on sustainability-related innovations. It brings together buyers (in both the private and public sector), suppliers and other expert entities such as consultancies to co-define problems and co-create novel solutions related to "Net Zero"

[1] In this study, a capability is defined as "the reliable capacity to do something as a result of intended action. Capabilities fill the gap between intention and outcome, and they fill it in such a way that the outcome bears a definite resemblance to what was intended" (Dosi, Nelson & Winter, 2000, p. 2).

challenges, for instance in the transport and construction sectors. The intermediary uses a problem-based sourcing approach to help buyers define their problems or unmet needs in broad terms and identify multiple potential solutions, while allowing suppliers to explore potential uses of their technologies and to test them in specific buyer contexts. Innovation intermediaries use a variety of business models (Howells, 2006) and serve multiple functions such as brokering connections, providing expertise, and promoting institutional change (Bessant & Rush, 1995; Selviaridis et al., 2023; Tran et al., 2011). Innovation intermediation often results from government industrial and innovation policies to foster collaborative innovation in particular sectors or technology areas (Spring et al., 2017).

Yet, research on supplier-enabled innovation has underplayed the contribution of innovation intermediaries. To date, there has been scant empirical research on how intermediaries support innovation in supply networks, specifically by addressing limitations in buyers' and suppliers' capabilities for collaborative innovation. Prior research (e.g., Kurpjuweit et al., 2021; Legenvre & Gualandris, 2018) has identified a range of capabilities that buyers need in order to collaborate with innovative suppliers, and suggested that such capabilities tend to be context-specific – for instance, they vary depending on supplier firm characteristics (Zaremba et al., 2017). This literature has recognized that suppliers also need capabilities to access buyer knowledge for innovation purposes, but empirical research on this aspect is scarce. More importantly, we know very little about why and how buyers and suppliers use intermediaries to help them undertake collaborative innovation.

Responding to Kumar et al.'s (2020) call to study how actors who are neither buyers nor suppliers influence innovation processes and outcomes in supply networks, we ask: *How do innovation intermediaries address limitations in the capabilities that buyers and suppliers need to collaborate for innovation, and with what outcomes?* To inform our study, we draw on the theoretical lens of indirect capabilities (Loasby, 1998). These refer to capabilities that firms

require to gain access to the capabilities of other organizations, such as suppliers and customers (Araujo et al., 2003). Examples include capabilities in spanning inter-firm boundaries, developing interfaces, and contracting (Spring & Araujo, 2014). Building on the indirect capabilities theoretical perspective and innovation intermediation literature, we conceive of intermediaries as actors who tackle shortfalls in the indirect capabilities that buyers and suppliers require in order to collaborate and contract for innovation.

We study the role of innovation intermediaries in supply networks in the context of the UK defense and public healthcare sectors. Combined, these two sectors accounted for almost half of the £379 billion UK public procurement spend in 2021-22 (Booth, 2022). Both the UK Ministry of Defence (MoD) and the English National Health Service (NHS), as large buyers, can stimulate supplier innovations that fulfil unmet public sector needs. At the same time, however, these buyers and their suppliers find it difficult to collaborate for innovation purposes, thus relying on intermediaries' services (Edler & Yeow, 2016). We study two prominent intermediary organizations, henceforth referred to as InnoDef and InnoMed respectively. They are both the result of UK Government policies to foster collaborative innovation that improves the delivery of public services. InnoDef is a private, for-profit entity, established to facilitate collaborative innovation between the MoD and defense suppliers. InnoMed is a public agency, one of the regional Health Innovation Networks (HINs) whose remit is to promote innovation to the NHS. The research focus is on how these innovation intermediaries compensate for the limitations in the indirect capabilities of buyers and suppliers.

We contribute to research on supplier-enabled innovation (e.g., Legenvre & Gualandris, 2018; Yan et al., 2020) by developing a model and set of propositions regarding the activities and underlying capabilities of intermediaries, and their impact on innovation sourcing outcomes. Our model elaborates the indirect capabilities theoretical perspective (Loasby, 1998; Spring & Araujo, 2014) by introducing additional types of indirect capabilities for collaborative

innovation and showing how these capabilities interrelate. In addition, we extend the literature on innovation intermediaries (e.g., Edler & Yeow, 2016; Katzy et al., 2013) by identifying capabilities for intermediation that are hitherto under-researched and adding insights regarding intermediaries' contribution to open innovation processes (Ogink et al., 2023).

2. Theoretical Background

2.1. Collaborative innovation in supply networks: the role of indirect capabilities

Capabilities reflect a firm's ability to deploy resources to attain its goals[2] (Salvato & Rerup, 2011). Organizations possess sets of capabilities which they can use for productive purposes (Holcomb & Hitt, 2007). Such capabilities are related to the manufacturing of products and delivery of services: for example, a firm might have a capability in making high-precision, steel forgings. Capabilities might also relate to innovation processes: for instance, an organization might have a capability in quickly and effectively introducing new products by leveraging its internal R&D resource base. Such production and innovation capabilities that organizations exercise to do things internally can be termed direct capabilities (Spring & Araujo, 2014).

Faced with a deficiency in a particular capability, a firm has two options: it can either develop the capability internally, or it can access it from somewhere else. Developing new capabilities – by adapting to changing markets, assimilating new knowledge, and reconfiguring existing capabilities (Eisenhardt & Martin, 2000) – requires dynamic capabilities (Teece, 2007; Wang & Ahmed, 2007). However, firms may lack these dynamic capabilities, or prefer, for other reasons, not to develop additional in-house capabilities. For example, capability development is often a slow process, which may be at odds with the urgency of the emerging

[2] The capabilities literature is vast and multi-faceted encompassing a set of distinct perspectives, notably the resource-based view, knowledge-based view, the routines perspective and the dynamic capabilities view (e.g., Barney, 2001; Becker, 2004; Eisenhardt & Martin, 2000; Foss, 1996; Teece, 2007). It is beyond the study's scope to review all these perspectives. Rather, we focus on the distinction between direct and indirect capabilities (Loasby, 1998) because of its relevance to the issue in focus: how buyers and suppliers can access each other's (direct) capabilities for innovation purposes.

need (Ketchen & Craighead, 2021). Firms can then turn to the second option – accessing other firms' capabilities. To do this, firms must have indirect capabilities (Spring & Araujo, 2014).

During the abductive research process we followed, discussed in the method section, we chose to adopt the indirect capabilities theoretical perspective as a plausible explanation for what was going on in our study, when it became evident that collaborative innovation challenges mainly stem from buyer and supplier capability shortfalls. We introduce this perspective here. The indirect capabilities view originates in the seminal work of Loasby (1998) who proposed that capabilities are constituted by direct and indirect know-how. "Know-how" refers not only to knowledge and skills, but also to when and where these are applied. "Direct" know-how is defined as knowing how to do something, while "indirect" know-how refers to knowing how to get things done for us by others (Loasby, 1998). Stated differently, indirect capabilities concern the know-how required to access the capabilities of other firms such as suppliers, customers, and business partners (Spring & Araujo, 2014). Organizing and gaining access to external capabilities is therefore a capability in itself (Araujo et al., 2003). A firm, in this sense, comprises a set of direct and indirect capabilities (Loasby, 1998).

Indirect capabilities have so far mainly been discussed conceptually. Araujo et al. (2003) and Spring and Araujo (2014) develop Loasby's ideas in order to understand their implications more specifically for the boundaries of the firm, and for procurement, respectively. Neither study includes empirical research; indeed, there are very few empirical studies that explicitly use the indirect capabilities lens (Mota & De Castro, 2004; Pulles et al., 2016). For instance, Pulles et al. (2016) find that two indirect capabilities – supplier selection and relational capabilities – help buying firms to secure supplier resources and build a competitive advantage. The Operations and Supply Chain Management (OSCM) literature on supplier innovation, more specifically, has empirically examined examples of what could be classified as indirect capabilities (e.g., Kurpjuweit et al., 2021; Zaremba et al., 2017). However,

it does not use that term and – even though it identifies some combinations of relevant capabilities, as discussed below – it does not have any equivalent unifying concept that encompasses all the ways in which one organisation can access the capabilities of another.

Research on supplier innovation has focussed on the need for *buying* firms to access external capabilities, specifically from suppliers (Johnsen et al., 2022; Koufteros et al., 2007; Lawson et al., 2015; Oke et al., 2013). This need is increasingly strong, due to the globalization and specialization trends in sectors (Kumar et al., 2020). Suppliers possess specialized technological capabilities that help buyers to innovate (Gao et al., 2015; Wowack et al., 2016) and improve their performance (Suurmond et al., 2020; Yan et al., 2017). To source innovation from suppliers, buying organizations must possess what we have termed indirect capabilities; for example, the ability to integrate information flows with suppliers (McCone-Sweet & Lee, 2009; Vanpoucke et al., 2014) and to design effective contracts and relational governance mechanisms (Roehrich & Lewis, 2014; Steinbach et al., 2018). Buyers also require capabilities in identifying their unmet needs, exploring supply options within their existing supply base and beyond (e.g., start-ups), and collaborating with suppliers in new product development projects (Legenvre & Gualandris, 2018). In addition, buying organizations need capabilities in selecting suitable suppliers to work with in innovation projects (Kurpjuweit et al., 2021), for example by assessing suppliers' innovativeness as well as the risks related to supplier leakage of the buying firm's proprietary knowledge to its competitors (Yan et al., 2020).

Concepts that go some way to defining sets of relevant indirect capabilities have also begun to emerge. Ketchen & Craighead (2021) advance the concept of "supply chain entrepreneurial embeddedness" to describe the ability of a focal firm to integrate small business entrepreneurial capabilities (e.g., creativity, ingenuity, and swift execution) available within its supply chain. These entrepreneurial capabilities allow buyers to identify novel ways to respond fast to sudden changes in supply and demand (Ketchen & Craighead, 2020) by collaborating

with innovative small businesses to benefit from their creativity and unique technological competences (Ketchen & Craighead, 2021). Alternatively, Zaremba et al. (2017) propose the concept of "new venture partnering capability" to capture a set of distinctive capabilities buyers must develop to be able to collaborate with innovative start-up suppliers. These capabilities include supplier evaluation, supplier development, communication, and relationship governance mechanisms that promote collaboration with small entrepreneurial firms.

It is notable that both "supply chain entrepreneurial embeddedness" and "new venture partnering capability", while being more integrative concepts, still only focus on the capabilities of buyers. This is in line with the broader literature on supplier innovation, which is concerned with sourcing capabilities needed to access the technological capabilities of suppliers (e.g., Legenvre & Gualandris, 2018). Despite the focus on buyer capabilities, prior research acknowledges that suppliers must also have capabilities to access buyer knowledge – such knowledge is a critical input for suppliers to develop innovations that meet buyers' demands (Alcacer & Oxley, 2014; Zaremba et al., 2016). For example, suppliers may require relationship-building capabilities to gain insights into the buying organization's processes of which the novel solution is a part (Kurpjuweit et al., 2018). The indirect capabilities perspective (Loasby, 1998) is useful in this respect because it remains agnostic as to which supply network actor must have these types of capabilities: both buyers and suppliers need indirect capabilities to access each other's knowledge, including for innovation purposes (Araujo et al., 2003).

Furthermore, the indirect capabilities view accepts that the capabilities required to collaborate for innovation are often specific to the context (Spring & Araujo, 2014), rather than general-purpose, as their development cannot be separated from knowledge regarding the specific technology or market (see also Narasimhan & Narayanan, 2013). For instance, capabilities might be specific to the type of counterpart such as new venture suppliers (Zaremba et al., 2017) or to the type and degree of maturity of the technology involved (Maghazei et al.,

2022). That said, whether generic or context-specific, the key point is that, between them, buyers and suppliers must have the indirect capabilities needed for innovation to take place.

As with direct capabilities, firms can either develop internally the indirect capabilities they need (e.g., Zaremba et al., 2017), or access them externally. In general, the scope of firms' productive activities is not the same as the scope of their knowledge. Firms may "know more than they do" (Brusoni et al., 2001, p.597) – that is, they invest in broad technological knowledge, but choose to use it to become knowledgeable buyers or supply chain partners, rather than deploying it in productive activities of their own. However, firms may also "know less than they buy" (Flowers, 2007, p. 317): have limited understanding of a specific technology or market, and thus seek assistance from third-party specialists who provide the requisite capabilities (e.g., solution exploration) on a contingent basis (Flowers, 2004). It is with such organizations who provide the "missing" indirect capabilities to facilitate collaborative innovation that we are concerned: in other words, with innovation intermediaries.

2.2. Innovation intermediaries

Innovation intermediaries are organizations who operate at the intersection between demand and supply (Howells, 2006) and facilitate innovation development and diffusion (De Silva et al., 2018; Stewart & Hyysalo, 2008). They include both private and public organizations with diverse missions and objectives. Key types of intermediaries include providers of knowledge-intensive business services and research and technology organizations (RTOs) supporting R&D and innovation activities (Bessant & Rush, 1995; Klerkx & Leeuwis, 2008a); web-based platforms connecting supply and demand for innovation (Colombo et al., 2015); and governmental agencies who influence policy direction in areas such as sustainable energy transitions (Kivimaa et al., 2019; Van Lente et al., 2003). The "clients" for intermediaries' services vary. Beyond the conventional view of intermediaries operating at the demand-supply interface and thus serving both buyers and suppliers simultaneously (Howells, 2006),

intermediaries may focus on serving exclusively buyers (e.g., Bessant & Rush, 1995; Colombo et al., 2015), suppliers – including small and medium-sized enterprises (SMEs) (Kirkels & Duysters, 2010) – or end-users (Boon et al., 2011; Hyysalo et al., 2018).

Innovation intermediaries perform various roles and activities, including contributing to processes of open innovation whereby a focal firm combines internal and external knowledge inputs to innovate (Chesbrough, 2003). Ogink et al. (2023) identify intermediation as a distinct mechanism of open innovation. In this context, intermediaries broker innovation-related interactions (Howells, 2006), help to identify suitable partners by matching needs with solutions (Katzy et al., 2013), and support the innovation process, for instance by creating experimentation opportunities (Stewart & Hyysalo, 2008). More generally, intermediaries help buyers and suppliers to co-develop innovations (Edler & Yeow, 2016), facilitate information exchange (Klerkx & Leeuwis, 2008b), and reduce cognitive distance between diverse stakeholders (Villani et al., 2017). They also provide access to finance (Polzin et al., 2016) and help shape rules and norms conducive to innovation (Selviaridis et al., 2023), thereby facilitating demand articulation (Boon et al., 2011) and innovation adoption (Kivimaa, 2014).

Intermediaries typically support buyer-supplier collaborative innovation through the projects they initiate and manage (Bessant & Rush, 1995; Edler & Yeow, 2016; Lichtenthaler, 2013). Such projects vary in scope including, for instance, assignments to help articulate needs, test novel solutions, or support their commercialization (e.g., Boon et al., 2011; Howells, 2006). Intermediaries thus have capabilities in setting up and managing collaborative innovation projects involving buyers, suppliers, and other expert entities (De Silva et al., 2018; Katzy et al., 2013; Van Winden & Carvalho, 2019). Intermediaries' projects are assessed using a diverse set of innovation outcomes, which depend on project aims and can include dimensions such as accelerated product development and prototype validation (Howells, 2006; Tran et al., 2011). In the context of intermediary support for innovation sourcing, key desired outcomes include

innovation adoption by the buyer, and any cost savings that the use of the innovation generates for the buyer (Edler & Yeow, 2016; Selviaridis et al., 2023).

OSCM research on supplier-enabled innovation has moved beyond buyer-supplier dyads to examine how structural characteristics and the complexity of the supply network influence innovation processes and outcomes (e.g., Bellamy et al., 2014; Carnovale & Yeniyurt, 2015; Chae et al., 2020; Potter & Wilhelm, 2020; Sharma et al., 2020). Kumar et al. (2020), however, point to the need not only to go beyond the dyad, but to also consider the role of organizations other than those directly involved in production. The authors refer, as examples, to studies examining the role of financial institutions as well as private-sector ecosystem coordinators and government agencies in influencing innovation outcomes. In the supply chain literature, Pagell & Wu (2009) argued for the reconceptualization of supply chains to include actors such as NGOs. Innovation intermediaries are another class of actors who are neither buyers nor suppliers of systems and components, but who nevertheless constitute nodes in the supply network and affect collaborative innovation processes and outcomes. Yet, as Kumar et al. (2020) imply, this kind of organizations has not been researched in the OSCM context.

In this study, we build on the innovation intermediation literature and the indirect capabilities perspective, to explain and theorize the role of innovation intermediaries in supply networks. We conceptualize intermediaries as actors addressing limitations in the indirect capabilities that buyers and suppliers must have to access each other's knowledge for innovation. Our empirical research examines how intermediaries' activities and capabilities are mobilised to support collaborative innovation, and the outcomes of intermediaries' support.

3. Method

Given the scant empirical research on the role of innovation intermediaries in supply networks in general, and on how intermediaries compensate for indirect capability limitations of buyers and suppliers in particular, we adopted a case-based research strategy (Barratt et al., 2011; Yin,

2009). This approach allowed us to ask open-ended, "how" and "why" questions and to develop a deep understanding (Voss et al., 2002) of intermediaries' role. Case research is well-suited for theory elaboration (Ketokivi & Choi, 2014). It allowed us to iterate between our data and the literature – especially the indirect capabilities theoretical perspective (Loasby, 1998) – in an abductive fashion (Dubois & Gadde, 2002) to develop a model and set of propositions regarding intermediaries' activities and capabilities. Based on our empirical research and abductive reasoning (Ketokivi & Choi, 2014), we elaborated the indirect capabilities theory by identifying additional types of indirect capabilities for collaborative innovation and certain relationships between these capabilities. The Discussion section provides further details.

We selected the UK defense and health sectors as suitable settings in which to study the role of innovation intermediaries because the UK MoD and the English NHS (as buying organizations) on the one hand, and their suppliers on the other, are limited in their ability to collaborate and to contract for innovation. For instance, the MoD faces challenges in developing specifications and contracts conducive to supplier-led innovation, at a pace consistent with evolving military needs and fast-changing technologies (HM Government, 2021). Similarly, the NHS is weak in its ability to engage effectively with innovative (small) suppliers and to integrate novel technologies, at a time when funding constraints and rising demand make innovation ever more essential (King's Fund, 2018). To address these issues and foster collaborative innovation in each sector, the UK Government established the two intermediaries: InnoDef and InnoMed.

3.1. Case study design

We employed an embedded, multiple-case design (Yin, 2009) to study the role of intermediaries. An embedded case design involves multiple units of analysis (Yin, 2009). In our study, the primary unit of analysis is the intermediary organization, as we focus on the capabilities and activities that intermediaries mobilize to support buyers and suppliers. The

sub-unit of analysis is projects which InnoDef and InnoMed initiated to support, respectively, the MoD and the NHS. Table 1 presents these projects, as the embedded cases. Each project involved intermediary engagement with the buyer and relevant supplier(s) and, in certain instances, other entities who contributed on an *ad-hoc* basis. Our analytical focus on projects, in keeping with prior literature stressing that intermediaries provide their support through innovation projects (e.g., Katzy et al., 2013), enabled us to study how intermediaries tackle buyer and supplier indirect capability shortfalls in the context of specific innovations.

InnoDef projects typically last six months, whereas InnoMed projects vary between six and 24 months, depending on supplier and /or buyer needs (e.g., testing, evidence generation, and adoption). InnoDef projects start at the idea generation stage, after receiving an MoD unit's request for support to solve a problem. They involve R&D and demonstration activities and conclude with a report of solution assessment and specification-setting recommendations. InnoMed projects typically exclude idea generation and conceptualisation stages, and focus on development, testing and commercialization aspects. Complementing the intermediary-level analysis, the project-level analysis allowed zooming in on what intermediaries actually do, and how the capabilities they possess allow them to do it.

We used a theoretical case sampling approach (Barratt et al., 2011) to select the two intermediaries. Specifically, we sought to sample both private and public intermediary organizations. We also considered different types of intermediaries in terms of their remit and service scope – while some focus on R&D and technical activities, others emphasize multiple areas of support including commercialization and innovation adoption (Howells, 2006). It was envisaged that case sampling along these criteria would help provide theoretically important insights with respect to how intermediaries seek to compensate for limits in indirect capabilities of buyers and suppliers, and the outcomes of intermediaries' support.

Table 1: The Innovation Intermediaries' Projects

Case	Project	Brief description of the project	Key beneficiaries
InnoDef	PR1	**Flight simulator solution**: R&D project to understand and define technical requirements (e.g., simulator full motion abilities), and to assess available solution options for affordable helicopter flight simulation system to be used to train pilots.	MoD procurement unit (Defence Equipment & Support); Royal Air Force; Suppliers
	PR2	**Open-source intelligence solution**: concept demonstrator project to identify requirements for an open-source intelligence gathering and analysis technology and to assess possible solutions; InnoDef was also asked to support the development of a suitable contracting approach	MoD and UK intelligence agencies; open-source software industry
	PR3	**Modernisation of military IT solutions**: series of demonstrators to identify IT requirements (e.g., in relation to cloud-based information sharing and handling of classified information), assess possible solutions (including integration of commercial off-the-self software) and design a suitable procurement approach allowing continuous system update in line with technological advancements	MoD Information Systems and Services agency; MoD Joint Forces Command; IT suppliers
	PR4	**Mission-critical training solution:** project to identify evolving requirements and develop a mission-specific solution to support 'command and control' capabilities of brigades on operation in foreign lands; InnoDef ran a series of concept demonstrators to understand requirements and develop training service	MoD (Army); software developers and training service providers
	PR5	**Visual training solution for military operations**: experimentation and simulation project to define requirements and assess technological solutions for visual training in the Ops control room	MoD (Army); simulation software solution providers
	PR6	**Future air refuelling solution**: R&D project to generate evidence regarding the requirements for a future aircraft refueller system and to assess available solution options, possible customization needs and related costs	Royal Airforce and Air Command; refuelling solution providers
InnoMed	PR7	**Hospital clinical audit solution**: project to identify hospital requirements regarding clinical audits (e.g., process mapping and work tasks) and to customise available solution. Organised trials of the solution in the hospital and helped analyse integration requirements such as training packages	Various NHS hospitals; Hospital clinical audit community; IT system suppliers
	PR8	**Hospital data management solution**: project to match hospital data management and information needs with IT platform's capabilities; identification of customization requirements; solution testing in secondary care; analysis of hospital incentives (e.g., revenue based on hospital activity levels)	Multiple NHS hospitals; IT platform suppliers
	PR9	**App for fast information gathering and remote diagnosis of young children's ailments**: project to test and assess the solution both in primary and secondary care; articulation of compliance requirements such as medical and informational and analysis of other integration requirements	NHS hospitals and general practitioners (GPs); Digital app supplier
	PR10	**Evacuation foldable stretcher**: project to identify requirements for the product's use in multiple settings (e.g., mental health); Trials and product demonstrations evidence safety and cost efficiencies; assessment of manufacturing changes to reduce costs; supplier education on sales approach	NHS mental health; social care community; Supplier of the product
	PR11	**Medical 3D-printing services**: project to facilitate structured dialogues with clinicians to understand their needs. Clinical trials in joint with a specific hospital and technology demonstrators in various medical areas (e.g., limb prosthetics and heart surgeries); generation and assessment of clinical evidence	NHS hospital; Supplier of the technology; 3D-prining medical supplier
	PR12	**Portable ultrasound in primary care**: project to define GPs' needs and evidence the technical and economic feasibility of the use of the device in GP clinics, including an evaluation of changes to existing care pathways and associated barriers. InnoMed advised supplier on sales and contracting approach.	NHS primary care networks and CCGs; Ultrasound device supplier
	PR13	**Technology to remotely assess swallowing difficulties:** project to evidence the technical and commercial feasibility of the technology and organize trials into care homes and hospitals	NHS hospitals; care homes; tele-swallowing solution supplier
	PR14	**Infection control in healthcare facilities:** project to test and assess the solution's operational and cost benefits in collaboration with two NHS hospitals. InnoMed also provided support on sales approach and solution implementation	NHS hospitals; cleaning solution supplier

Following this sampling logic, we identified two suitable intermediaries, InnoDef and InnoMed. Our case selection focused on intermediaries operating exclusively in the UK public sector to control for differences between public and private sector contexts (e.g., public procurement rules and processes) and any country-level institutional differences (e.g., in laws

and regulations). Our sampling also controlled for the intermediaries' service orientation (i.e., who the intermediaries' "clients" are), by selecting intermediaries that seek to engage with *both* buyers and suppliers, rather than with either side exclusively.

To select the projects that each intermediary managed, we employed criterion sampling (Patton, 2002). Two main selection criteria were: a) intermediaries' engagement with both the buyer and supplier(s) relevant to the project, and b) the depth of such engagement – we focused on projects for which the intermediary worked closely with the buyer and supplier(s). We first asked InnoDef and InnoMed staff to provide basic information about all projects they had managed over the past five years: InnoDef had executed 240 projects, and InnoMed 180. For comparison purposes, it was decided to focus on projects concerning innovations at their commercialization stage (rather than in early development), which the two buyers had already been considering as supply options. This scoping decision, which also enabled studying relevant innovation sourcing outcomes (innovation uptake and cost savings), reduced relevant projects to 279 in total (144 for InnoDef; 135 for InnoMed). Furthermore, through early discussions with InnoDef and InnoMed managers and our review of intermediaries' annual reports we identified a subset of projects fulfilling the two criteria above. Considering research capacity limitations, we targeted ten InnoDef projects and were able to study six of them. In the InnoMed case, we pre-selected fifteen projects and were able to study eight of them.

3.2. Data collection

Data collection involved a combination of semi-structured interviews, documents, and participant observation. Table 2 provides an overview of the data collected per case study. Across the two cases, we conducted 50 interviews, also collecting data on the fourteen intermediary projects we focused on. For each project, we sought to gain access both to the buyer and supplier side, in addition to the two intermediaries. InnoDef and InnoMed managers facilitated access to the buyers and relevant suppliers as far as possible.

Table 2: Data Collection Overview

Case	Methods	Details of data collected	Key themes addressed
InnoDef	**18 semi-structured interviews**	- 8 interviews: InnoDef staff: Managing Director (twice); Technical Director; Delivery Director; three Project Leads (one interviewed twice) - 2 interviews: MoD DE&S managers: Innovation Lead and MoD-InnoDef Liaison - 2 interviews: MoD end-users /Royal Air Force Programme Managers - 6 interviews: defense suppliers (senior and middle managers; one interview per supplier)	Challenges regarding innovation contracting in the MoD; defence procurement capability limits; Supplier limitations in dealing with the MoD; InnoDef's capabilities and work to support MoD and suppliers; InnoDef projects and practices; outcomes and impacts of InnoDef's work
	25 organizational documents and archival records	Multiple reports and archival records including InnoDef's R&D project memos; InnoDef's annual performance review reports; MoD case studies of InnoDef's projects; MoD procurement function's presentation regarding R&D exploitation and innovation procurement; and InnoDef's series of White Papers on effective ways to improve and accelerate defense innovation	Details about InnoDef projects in focus (e.g., scope /aims, work and outcomes); InnoDef's performance achievements at the project level and beyond; documentation of MoD procurement capability shortfalls
InnoMed	**32 semi-structured interviews**	- 7 interviews: InnoMed staff: Chief Operating Officer; Assistant Commercial Director; three Commercial Managers (one interviewed twice) - 5 interviews with NHS procurement professionals: Assistant Director at Procurement Development agency, Procurement Directors at four NHS hospitals (one interview each) - 20 interviews: SME suppliers (founders and senior managers; one interview per supplier)	Innovation sourcing challenges in the NHS context; NHS procurement capability deficiencies; SME supplier limitations; How InnoMed supports the NHS and SME suppliers; InnoMed's processes and practices; Outcomes of InnoMed's work
	30 organizational documents and archival records	Collection and analysis of archival records including InnoMed's annual reports, NHS procurement policy reports, documents on procurement practices (e.g., at NHS Trusts), SME supplier presentations of their novel solution, and reports on NHS adoption rate and scale of innovative technologies /products	Details about InnoMed's projects and related support for SME suppliers' innovations in focus; InnoMed's support activities for the NHS; InnoMed's performance and influence
	Participant observation of two InnoMed workshops	Observation of two 2-hour InnoMed workshops targeting SME suppliers on: 1) 'NHS procurement overview and how to sell into the NHS', and 2) 'NHS governance structure and key priorities'. Detailed field notes were taken and memos were written immediately after each sesssion.	Challenges SMEs face in relation to selling their innovations into the NHS; InnoMed educating suppliers regarding NHS's procurement processes, regulatory requirements and operational realities at various care settings

The first author conducted all interviews, with the second author participating in five of them. We spoke to senior and middle managers of the two intermediaries such as Managing Director, Technical Director, Chief Operating Officer, and Commercial Managers. We also interviewed representatives of the two buying organizations involved, such as the Defence Equipment & Support (DE&S) Innovation Lead, and Procurement Directors of NHS hospitals. We also spoke to senior managers of supplier firms to understand their challenges, and how

they benefited from involvement in InnoDef and InnoMed projects. All but three interview sessions were audio-recorded and transcribed, resulting in 568 pages of transcription text. When recording was not permitted, detailed notes were taken during and immediately after the sessions to ensure data accuracy. An interview guide (Appendix A) was developed, but it was flexibly employed to consider context-specificities related to the UK defense and healthcare sectors. The guide also included actor-specific questions: while some questions were focused on the two intermediaries, others were specific to the buying organizations or supplier firms.

The interview data was triangulated (Jick, 1979) and augmented through documentary evidence and observation data. Specifically, we gathered and reviewed 55 documents including project summary reports, publicly available information related to the intermediaries' projects, and annual reports and presentations produced by the two intermediaries. These sources proved particularly helpful for complementing our findings regarding intermediaries' support activities and the outcomes of individual projects in terms of innovation uptake and cost savings. Observation of two workshops that InnoMed ran (see Table 2) for the benefit of SME suppliers helped us to understand the limitations facing innovative small firms when attempting to supply their innovations to the NHS. It also provided insights regarding how intermediaries seek to educate suppliers to support the implementation of their novel solutions.

3.3. Data analysis and coding

We conducted both within- and cross-case analyses (Yin, 2009). Within-case analysis provided detailed insights regarding each intermediary's capabilities and activities to address indirect capability shortfalls of buyers and suppliers, and their impact on innovation sourcing outcomes. Cross-case analysis helped to identify similarities and differences between the two intermediaries, and between the projects that the intermediaries executed. Following Gioia et al. (2013), during the within-case analysis stage we sought to code the data for each intermediary individually. We coded and analyzed the data manually. Using initially an open-

coding approach (Strauss & Corbin, 1990), we assigned codes to excerpts from the interviewee accounts and documents in an inductive fashion. For instance, the quote from the interview with the Managing Director of InnoDef "*The project team consists of experts from various sources: MoD, industry and academia. A 'best athlete' approach is followed for the formation of the project team, meaning choosing the most suitable individuals for a specific project"* was coded as "forming cross-organizational teams of experts". In general, the first-order codes reflected the terms used by interviewees referring, for instance, to buyer and supplier capability limitations and forms of know-how that intermediaries possessed and used.

As a next step, we compiled the case-specific results into data tables structured around the key emerging constructs (Miles & Huberman, 1994). Examples of these tables are provided in the cross-case analysis section. At this stage, we transitioned from inductive to abductive coding in line with Gioia et al. (2013), as we sought to systematically compare our data with the literature. Our preliminary analysis suggested that challenges related to collaborative innovation between buyers and suppliers mainly originate in their capability limits. We subsequently consulted the capabilities literature and found it useful to adopt, specifically, the indirect capabilities perspective (Loasby, 1998) because, as explained in Section 2, it focuses on capabilities required to access the capabilities of supply network counterparts. Accordingly, we re-examined our first-order codes considering key elements of indirect capabilities such as boundary-spanning, interfacing, contracting, and testing (e.g., Araujo et al., 2003). This abductive coding process, consistent with a theory elaboration approach (Ketokivi & Choi, 2014), helped to progressively group our set of 25 first-order codes into theoretically informed, second-order themes using axial coding (Strauss & Corbin, 1990). For example, the first-order codes "forming cross-organizational teams of experts" and "involving end users", as specific forms of know-how, were collapsed into the second-order code "expertise-spanning", as a capability of intermediaries, informed by the concept of boundary-spanning indirect capability

(Spring & Araujo, 2014). Similarly, the second-order theme "interface-building", informed by the interfacing indirect capability (Spring & Araujo, 2014), was derived by grouping the first-order codes "standardizing and facilitating interactions" and "matching problems with solutions". The literature-informed second-order codes were subsequently iterated and grouped into aggregate dimensions – for instance, the "expertise-spanning" and "interface-building" codes were synthesised into the dimension "creating workspaces for R&D and experimentation", as one of the five activities of intermediaries we uncovered. Appendix B presents the resulting data coding structure. Appendix C provides full details of the data coding and analysis process, including the initial steps we followed to derive the core set of first-order codes and the logic we used to drop certain unrepresentative codes.

Data was coded by the first author and a research assistant, who independently worked on a subset of the data to ensure rigor. The independent coding of the two researchers was then assessed, resulting in more than 93% inter-rater reliability. We discussed discrepancies in data interpretation until resolving all disagreements. We also shared our findings with key InnoDef and InnoMed participants to ensure credibility and confirmability (Pratt et al., 2020). The data triangulation measures described earlier also helped to ensure our results' trustworthiness.

4. Analysis and Findings

4.1. Within-case analysis

For each case, the analysis focused on limitations in buyer and supplier indirect capabilities, how the intermediary supports collaborative innovation between buyers and suppliers, and the impact on innovation sourcing outcomes. The detailed within-case analyses for InnoDef and InnoMed are shown in the respective tables in Appendix D. The within-case analysis included the specific projects (PR1-PR14) and offered rich insights regarding the types of know-how that intermediaries possess and use. To assess whether the intermediaries' forms of know-how emerging from the interviews were relevant to each project, we looked for interviewee

statements or documentary evidence referring to a specific project. We coded "✓" if we could explicitly observe that a project involved a specific form of intermediary know-how, and "✗" where there was no such evidence. When the intermediary's specific form of know-how was not applicable or relevant to a specific project, we coded "n/a".

This approach was used to code and analyse the data (at project level) for all intermediary activities we uncovered, for example "refining definitions of requirements" and "de-risking novel solutions". De-risking refers to intermediaries' efforts to significantly reduce the risk that the innovations considered would not be fit to solve the buyer's problem. Regarding "innovation sourcing outcomes", we combined interview data and documents (e.g., intermediaries' annual reports and UK Government press releases) to examine the intermediary's impact in terms of a) the uptake of novel solution by the buyer, and b) cost savings for the buyer. We first analysed each outcome separately at the project level. For the uptake outcome, we coded "✓" if there was evidence showing that the novel solution was adopted and integrated into the buying organization's service delivery system. We coded "✗" if the innovation was not adopted. Regarding cost savings, we coded "✓" if the solution generated savings for the buyer. We coded "✗" if cost benefits were not realized in a specific project. For the cost savings outcome, we additionally coded "n/a" in two projects where we could not verify based on available evidence whether cost reduction was achieved or not. To examine the intermediaries' impact on these outcomes *more generally (i.e., beyond the fourteen projects)*, we used intermediary, NHS, and MoD reports. Next, we briefly outline the two cases.

4.1.1. InnoDef

The intermediary is a private-sector entity used by the MoD to support collaborative innovation with suppliers without restricting the Ministry's ability to benefit from competition between suppliers for MoD contracts. The MoD pays InnoDef per project it initiates in addition to an annual fixed fee. InnoDef provides a commercially neutral space through which the MoD and

defense suppliers collaborate to fulfil unmet defense needs. Other expert entities (e.g., universities and consultancies) can be involved in projects as necessary. The MoD acts as a single customer, meaning that the Armed Forces as end users, and DE&S and the Information Systems & Services (ISS) procurement units, have access to the intermediary's services. InnoDef connects the MoD with defense suppliers, who participate in projects either as "partners" (large defense suppliers) or "associates" (e.g., small suppliers).

InnoDef's projects are triggered by a specific problem facing an MoD unit. Any supplier can participate in projects of interest. MoD end users and procurement units are not mandated to use InnoDef and engagement in the intermediary's projects is voluntary. A core team of InnoDef senior managers conducts an early evaluation of the problem at hand to determine a suitable approach and formulate the project team. The most suitable experts are then selected to join the project team. These include employees from suppliers and other organizations who are transferred to InnoDef to work full-time on the project. Project activities vary depending on the problem at hand, but typically entail experimentation, applied research, and concept and technology demonstrators. The InnoDef project team delivers to the MoD sponsor a report of findings and recommendations and supports exploitation of project outputs. The projects generate objective evidence which helps the MoD to clarify its needs, specify requirements, and make informed decisions about supplier selection, contracting and innovation implementation. Overall, InnoDef's activities contribute to the uptake of supplier innovations and help the MoD to avoid unnecessary costs (see Appendix D for details).

4.1.2. InnoMed

InnoMed and other Health Innovation Networks (HINs) are regional public agencies funded by the UK Government Office for Life Sciences and operate based on a licensing model. This means that InnoMed is paid an annual fixed amount through taxpayer money. The intermediary supports NHS hospitals and general practice (GP) clinics to source and adopt innovations. Any

NHS provider in the region can use InnoMed's services to drive improvement in patient outcomes, albeit engagement with InnoMed is optional. Similarly, any supplier with a relevant innovation can work with InnoMed. Because the intermediary emphasizes economic growth outcomes, it actively supports small suppliers who otherwise find it difficult to connect to clinicians and have their innovations tested. InnoMed works with other HINs to accelerate the adoption of proven innovations nationally and promote an innovation culture within the NHS.

InnoMed seeks to systematically relate the NHS's problems to suppliers' capabilities and novel solutions. It performs horizon scanning activities and raises awareness within the NHS of innovative technologies that could be exploited to fulfill unmet healthcare needs, both in the region and nationally. In its projects, InnoMed facilitates interactions between the NHS and (SME) suppliers. It helps the NHS to define its unmet requirements and contributes to processes of evidence generation and assessment of new medical technologies and products. InnoMed also analyzes and addresses barriers to NHS adoption and integration of novel technologies, for instance with respect to changes in "care pathways" (approved protocols and processes of delivering treatment) and incentives. InnoMed's work has contributed to the uptake of new solutions and healthcare cost savings (Appendix D), though the latter are rather low considering the large spend of the English NHS.

4.2. Cross-case analysis

We created tabular data displays to identify patterns in relation to a) shortfalls in buyer and supplier indirect capabilities, b) the intermediaries' know-how and associated capabilities, and c) impact on innovation sourcing outcomes. For the latter two themes, we used cross-case tables to examine the relevance of each of the issues across the intermediaries' fourteen projects. Table 3 exemplifies the detailed, project-level analysis regarding one of the five intermediaries' activities we identified: "creating workspaces for R&D and experimentation".

Table 3: Innovation Intermediaries Create Workspaces for R&D and Experimentation

Constructs	InnoDef						InnoMed								Sum
	PR1	PR2	PR3	PR4	PR5	PR6	PR7	PR8	PR9	PR10	PR11	PR12	PR13	PR14	n=14
Expertise-spanning															
Forming cross-organizational teams of experts	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	×	**12**
Involving end-users	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	**12**
Interface-building															
Standardizing and facilitating interactions	✓	✓	✓	✓	✓	✓	×	×	✓	n/a	×	n/a	✓	✓	**9**
Matching problems with solutions	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	**12**

✓= Yes, project involved this intermediary know-how; ×= no, project did not involve this know-how; n/a=not applicable.

The cross-case tables concerning the four other intermediaries' activities (i.e., refining definitions of requirements; de-risking novel solutions; supporting contracting; and facilitating solution implementation) as well as the intermediaries' impact on innovation uptake and cost savings outcomes are presented in Appendix E. The cross-case analysis also examined how the (sub)constructs relate to each other – for instance, how intermediaries' expertise-spanning capabilities influence the assessment and de-risking of novel solutions. The supporting pattern-matching tables are shown in Appendix F and referred to in the following sections.

4.2.1. Limitations in buyer and supplier indirect capabilities for collaborative innovation

The cross-case analysis revealed shortfalls in indirect capabilities across buyers and suppliers (Table 4). We have developed an empirical account of the indirect capabilities that are relevant for collaborative innovation in defense and health settings. There is no pre-existing, empirically derived framework for indirect capabilities, although Spring & Araujo (2014) do outline a categorization based on their conceptual work. We extend this categorization by identifying additional indirect capabilities that buyers and suppliers require, but may be lacking, such as those related to solution implementation and commercialization, respectively (see Table 4).

Regarding buyer indirect capability shortfalls, we identified three issues. First, buying organizations are limited in their ability to articulate and specify their needs and requirements

(including the future ones) in ways that would avoid unnecessary costs, foster supplier innovation, and cater for evolving buyer needs in keeping also with technological change.

Table 4: Observed Limitations in Indirect Capabilities of Buyers and Suppliers

Key constructs	Related sub-constructs	Key issues evidenced
Buyer indirect capabilities limits	Weak ability to articulate needs and requirements	• Over-specified requirements restrict supplier-enabled innovation and increase costs unnecessarily • Specification processes do not allow for changing buyer requirements in pace with technological advances
	Limited insight into solution /supply market options	• Buying organizations have limited ability to identify and assess possible technological options • Buying organizations lack knowledge regarding which suppliers could fullfil need, what they can offer, and what works ('art of the possible')
	Limits to contracting and solution implementation	• Inflexible contractual frameworks hardly cater for solution adaptation in line with technological changes • Contracting processes and practices not conducive to (SME) supplier innovation • Limited ability to proactively analyze organizational, regulatory and cultural factors influencing innovation integration into service delivery system
Supplier indirect capabilities limits	Limited understanding of needs and use in context	• Suppliers lack in-depth understanding of buyer's needs, including future ones • Suppliers have limited insight into buying organization's operating context, and how the novel solution fits existing service processes and activities
	Inability to test solution in context	• Suppliers have limited ability to create opportunities for trialing and testing their solutions in real-life operating settings • Suppliers often lack robust evidence to prove the benefits of the novel solution
	Limited commercialization know-how in context	• Suppliers lack knowledge regarding routes to market and factors driving adoption of innovations by the buying organization

Second, buying organizations lack well-developed capabilities for identifying and assessing new and emerging technologies. They also have a rather narrow view of which suppliers have the technological capabilities and offerings that could help fulfil buyers' unmet needs: too often, both buying organizations exclude innovative small suppliers originating from other, non-defense (e.g., Artificial Intelligence) or non-health (e.g., 3D-printing) domains.

Third, buyers have gaps in contracting and innovation integration capabilities. Procurement professionals both within the MoD and the NHS often do not know how to design contracting approaches that promote flexibility and supplier innovation in line with evolving requirements of end-users. Although reluctance to engage with novel contracting practices can partly be attributed to risk aversion, capability gaps were seen as a prominent challenge: *We [NHS procurement professionals] are very good at pre-prepared products in a box […] Where we get out of our comfort zone is [a supplier] coming along and saying, well, you can have*

that box but, actually, we've been thinking we can do something else […] And then we get all iffy and puffy and we're out of our comfort zone and get into areas where we get a bit less in charge" (Procurement Director, NHS Hospital). Both buyers also grapple with anticipating the organizational issues impeding integration of innovations into their service delivery systems.

With respect to suppliers, we again identified three key limitations. First, suppliers are limited in their ability to understand the buying organization's current and future needs, the buyer's operating context, and how solutions would fit existing service processes of end users. These capability limitations are especially acute for suppliers that originate from industries other than defense and healthcare, and can be attributed to supplier difficulties in accessing decision makers within the buying organizations as well as relevant end-users: *"What we would have liked would have been […] to meet with what you might call industry experts who could have said, 'That's a good idea,' or, 'No, that'll never work,' or, 'Have you considered the problems of this or that?"* (Co-founder, Supplier of security solutions). Interviewees also stressed suppliers' inability to ask the right questions and quickly get to the bottom of buyers' problems. Second, suppliers face limitations in their ability to test their innovations specifically in the buying organization's setting and generate evidence to demonstrate their cost-effectiveness. Third, suppliers have limited understanding of possible routes to market for their innovations, and of the factors driving adoption of their technologies by the buying organization. These issues are particularly pertinent for innovative small suppliers who have limited understanding of the market context and a limited ability to commercialize their novel ideas, as compared to more established suppliers.

4.2.2. How intermediaries address shortfalls in indirect capabilities of buyers and suppliers

Intermediaries support buyers and suppliers through five key activities. Table 5 sums up the activities and underlying capabilities of intermediaries and shows how frequently these were observed across the fourteen projects we studied in detail.

Table 5: How Innovation Intermediaries Address Shortfalls in Indirect Capabilities of Buyers and Suppliers

Constructs (aggregate dimensions)	Sub-constructs (second- and first-order codes)	Studied projects (n=14)
Creating workspaces for R&D and experimentation	**Expertise-spanning**	
	- Forming cross-organizational teams of experts	12
	- Involving end-users	12
	Interface-building	
	- Standardizing and facilitating interactions	9
	- Matching problems with solutions	12
Refining definitions of requirements	**Needs articulation**	
	- Articulating future and unmet needs	10
	- Reframing and refining problems	9
	Needs translation (into solution requirements)	
	- Supporting suppliers understand needs and use	14
	- Analyzing needs vis-à-vis technological options	10
De-risking novel solutions	**Solution testing**	
	- Running experiments and demonstration projects	12
	- Organizing trials and field tests of solutions	10
	Solution assessment	
	- Generating evidence: technical, commercial and organizational	12
Supporting contracting	**Specification-setting**	
	- Developing industry-informed specifications	9
	Contracting	
	- Consulting on contracting process and contract design	9
Facilitating solution implementation	**Innovation integration**	
	- Analyzing buyer requirements for solution integration	12
	Innovation adoption facilitation	
	- Educating suppliers to facilitate innovation adoption	10

4.2.2.1. Creating workspaces for R&D and experimentation

The intermediaries seek to facilitate collaborative innovation by spanning organizational boundaries and sets of capabilities, and developing interfaces that enable constructive interactions among buyers, suppliers, and other relevant actors. Intermediaries span boundaries and draw together technical capabilities through the formation of cross-organizational teams of experts. The intermediaries have internal processes and invest resources in appointing external experts to their projects. For example, InnoDef senior managers dedicate time in evaluating the expertise needed for each project they initiate. They subsequently advertise vacancies, assess candidates, and select suitable individuals to work on the project. These experts come from a diverse set of organizations including the MoD, defense suppliers, universities, and consultancies. Intermediaries also involve end-user communities in their projects. For instance, InnoMed staff leverage their extensive connections within hospitals to

recruit clinicians, who are process experts and can provide valuable feedback on the use context and desired solution features. InnoMed also draws on external capabilities, for example from manufacturing experts and health economists who support its projects on an *ad hoc* basis.

Intermediaries also standardize and facilitate interactions between buyers and suppliers in order to foster collaboration. This is achieved through the intermediaries' IT-based collaborative work environments, intellectual property (IP) systems and standard operating principles and procedures (Appendix D). For example, InnoDef's IP framework protects the "background IP" contributed by competing suppliers, thereby incentivizing their openness and full engagement in projects. InnoDef's set of principles (e.g., impartiality) enables cooperation during projects. Intermediaries facilitate meetings and ongoing dialogue. Beyond reducing physical and cognitive distance between buyers and suppliers, intermediaries also help to match problems or needs with technological solutions. This matchmaking is supported by intermediaries' staff horizon scanning to identify new technologies and suppliers that could fulfil unmet needs. For example, InnoMed and other HINs offer "*a high quality, high value gateway for any NHS organisation needing support or help with innovation and provide industry with focused points of access to the NHS […] work with industry to scope problems and jointly develop solutions to key health challenges"* (Department of Health, 2011, p. 19).

4.2.2.2. Refining definitions of requirements

Intermediaries help buyers improve their ability to articulate their problems and needs (see Table 4), and to translate those needs into viable solution requirements. This is mainly achieved through project-based work. InnoDef's projects, for example, support the MoD not only to articulate its actual needs, but also to reframe its perceived problems. Similarly, InnoMed managers engage with clinicians and decision makers at NHS hospitals to help shape and define unmet healthcare needs. Intermediaries, positioned at the demand-supply intersection, support buyers to translate their needs into requirements that consider supply market capabilities.

This translation process also involves intermediaries supporting suppliers to increase their understanding of buyer needs (refer to Table 4). Specifically, intermediaries dedicate resources and staff to supplier coaching and consultations on defence or health market requirements. In addition, through partaking in intermediary projects and accessing end users, suppliers better grasp how their innovations would fit existing buyer processes. Intermediaries also have experts who analyze buyer needs vis-à-vis technological options. As InnoMed's Assistant Commercial Director noted, translating needs into solution requirements is about discovering "what the art of the possible might be" in specific technology areas or markets.

The cross-case analysis shown in Appendix F (Table F.1) suggests that intermediaries' interface-building capabilities play a key role in translating needs into requirements that are technologically feasible and informed by supply market knowledge. Intermediaries' work to match problems with solutions enhances supplier understanding of buyer needs. It also triggers constructive dialogue between buyers, intermediaries, and suppliers as to what is asked for vis-à-vis what is technologically feasible. Analysis across the fourteen projects (Table F.2, Appendix F) confirms that intermediaries' work to match problems with solutions helps to develop common understanding of feasible solution requirements. As the Managing Director of InnoDef put it, for instance: *"The [InnoDef] model focuses on providing the MoD with advice on how to identify and better specify its requirements. The model operates between the problem space and the solution space based on 'divergence' and 'convergence' principles".*

4.2.2.3. De-risking novel solutions

Intermediaries help to reduce technological and market uncertainty and to de-risk novel solutions by contributing to testing and assessment processes. Both InnoDef and InnoMed create opportunities for testing and evidence generation, thus helping to address buyer and supplier capability limitations in these areas (Table 4). Intermediaries invest resources to perform their own experiments and demonstrations and assist in setting up field tests and trials

by coordinating all relevant actors. InnoDef projects, for instance, include demonstrators, whereby a promising technology is put to the test by the project team. Crucially, both intermediaries operate based on a principle of "impartiality", meaning that testing and assessment activities are carefully designed to be technology- and supplier-neutral. This is also reflected in the composition of the project teams that the intermediaries manage.

Intermediary-enabled testing and assessment are seen by suppliers and buyers as invaluable because they generate robust evidence regarding the technical and commercial feasibility of innovations (Appendix D). For suppliers, such evidence can be instrumental for explicating and showcasing the benefits of their innovation, including its value for the buyer (e.g., resource productivity benefits). Intermediaries' staff encourage and actively support (SME) suppliers to perform such valuations. The generated evidence can also be used as input for further refinement of technical features of the solution. Evidence-gathering enabled by intermediaries also include organizational and supply chain aspects: the former cover required changes within the buying organization to facilitate the integration of novel technologies, while the latter refer to capability and capacity in the extended supply chain to produce and distribute the innovation at scale. InnoDef interviewees used the term "business readiness level" when referring to these issues: *"InnoDef helps you understand more objectively where you're really at. We could come across any of those things in that business readiness level. It could be there are no supply chains out there for this. If you wanted to buy one of these things, there is no market for it. You'd have to establish a market for it"* (Innovation Lead, MoD DE&S).

Cross-case analysis shows that intermediaries' expertise-spanning capabilities facilitate evidence-based assessment of novel solutions, thereby helping to de-risk them. Specifically, intermediaries' forming of cross-organizational teams of experts and involving end-users in projects is instrumental for assessment and de-risking of solutions (Table F.1, Appendix F). Analysis across the fourteen projects confirms that expertise-spanning capabilities enable

testing, assessment, and evidence generation (Table F.3, Appendix F). As an example, in the project PR12 InnoMed staff introduced the supplier to end-users, which in turn enabled the trialling of the solution and helped produce evidence: *"We have got a few GPs [General Practitioners] already using [the ultrasound device] who are tracking and putting their information down…what cases they're identifying with ultrasound and then, you know, the pathways…documenting their usage and how it's coming in handy. So, we've already got a few champions who are doing that"* (Sales Manager, Supplier of portable ultrasound solution).

4.2.2.4. Supporting contracting

Intermediaries leverage their close interactions with suppliers and the knowledge generated through projects to help buyers address their capability limitations in specification-setting and contracting (see Table 4). The analysis suggests that intermediaries' project-based work generates knowledge regarding actual buyer needs and requirements as well as supplier technologies, which is then transferred by intermediaries to buyers to inform the development of specifications (Appendix D). The intermediaries' internal processes cater for the development of project reports for buyers and other technical publications, referred to by several interviewees as "artefacts". In addition, intermediaries consult buyers on contracting processes that improve agility in procurement and facilitate innovation adoption. InnoDef managers advise on contracting that incentivizes continuous upgrading of solutions in keeping with technological advancements and evolving needs of MoD end users. For example, in project PR2 InnoDef convinced Defence Equipment & Support (DE&S) to use a contractual approach more conducive to innovation: *"[…] you might then also want to have another contract which is for what we will call an innovation partner, and the innovation partner's job is solely to go out and look for disrupters - new technologies, new ways of addressing the same problem, new threats - which the contract, however well written for the service delivery partner*

cannot take account of" (Delivery Director, InnoDef). Similarly, InnoMed supports NHS procurement staff to explore contracting models that enable fast uptake of supplier innovations.

The cross-case findings suggest that intermediaries' needs articulation and translation capabilities contribute significantly towards their work to support contracting, especially regarding buyer assistance in specifications development. The analysis shown in Table F.1 (Appendix F) indicates that intermediaries' help in articulating buyer needs, and in relating those needs to supplier capabilities and technological options, facilitates the development of informed specifications of requirements. The project-level analysis (Table F.4, Appendix F) corroborates this: projects that included intermediaries' support to articulate and translate needs into feasible solution requirements led to informed specifications.

4.2.2.5. Facilitating solution implementation

Intermediaries support buyers and suppliers to address their respective limitations (Table 4) by analyzing requirements for adoption and integration of novel technologies within the buying organization. Intermediaries' decision support processes explicate the need to analyze innovation integration requirements and both intermediaries have experts who perform such analyses. InnoDef managers, for example, seek to anticipate issues across all "Defense Lines of Development": aspects such as end-user training, compatibility with legacy IT, and logistical support. Similarly, InnoMed managers support the analysis of any changes in existing care pathways that the adoption of a novel technology would require. Intermediaries also dedicate resources to educate suppliers about possible barriers to innovation adoption, and how to overcome them. InnoMed managers, for instance, run workshops to help suppliers understand how the NHS is structured and how it operates (Appendix D), which is especially important for digital technology-based firms with no prior experience of the NHS market.

Analysis shown in Appendix F (Tables F.1 and F.5) demonstrates that intermediaries' testing and assessment capabilities contribute significantly towards their work to facilitate

solution implementation. The objective evidence generated through testing and assessment activities produces insights regarding innovation integration requirements and adoption barriers. As InnoMed's Assistant Commercial Director put it: "*the NHS is not a FMCG [Fast Moving Consumable Goods] sell. Some of our [SMEs] maybe have got transferred from those other sectors and it's a very different way to build your value proposition and your business case […] you need an evidence base and evaluation, you need a service integration evaluation to understand the practicalities of how [the NHS] adopt new technology […] That kind of support for valuation and that value proposition is also part of our additionality"*.

4.2.3. Innovation sourcing outcomes

Intermediaries contribute to innovation uptake by buyers. Table F.6 (Appendix F) shows that in twelve out of the fourteen projects uptake was successful. This is corroborated by analysis beyond the fourteen projects – 131 InnoDef projects (out of 240 in total) led to MoD uptake of innovations. InnoMed projects contributed to NHS adoption of 95 solutions, from a total of 180 solution-specific projects. Innovation uptake was thus achieved in more than half of each intermediary's projects. We deem this a positive outcome, given the widely reported challenges facing the MoD and the NHS to adopt innovations at pace and scale (Castle-Clarke et al., 2017; House of Commons Defence Committee, 2023; King's Fund, 2018). More generally, innovation is an inherently uncertain and risky process and thus "success" can never involve a nearly complete rate of adoption and use of innovations (Tidd & Bessant, 2009).

The cross-case analysis suggests that intermediaries' capabilities in innovation integration and adoption facilitation contribute positively towards innovation uptake. Table F.7 (Appendix F) shows that intermediaries' analysis of solution integration requirements was conducted in all twelve projects featuring successful innovation uptake. Similarly, intermediary's adoption facilitation through supplier education was observed in ten out of the

twelve successful projects. By contrast, such intermediary capabilities and activities were absent in the two projects that failed in terms of innovation uptake.

Regarding cost savings, Table F.6 in Appendix F shows a positive outcome in five out of the fourteen projects. Savings were not achieved in seven projects, and the outcome could not be verified in two projects. Additional analysis based on secondary data does provide evidence of cost reduction more generally, but we deem such evidence inconclusive. According to InnoDef's annual reports, for instance, the intermediary helped the MoD to avoid costs of £1.89 billion. However, our interviews revealed that this self-reported figure includes estimates of *potential* cost avoidance based on scenarios of requirement levels, rather than *actual* savings realized by virtue of the integration of new technologies into military service operations.

The analysis in Appendix F reveals a nuanced relationship between intermediaries' specification-setting and contracting capabilities on the one hand, and cost savings on the other. Our comparative analysis between projects resulting in cost savings and those where savings were not achieved (Table F.8, Appendix F) shows that intermediaries provided contracting support in all five projects that led to savings. Contrastingly, contracting support was not provided in most projects that failed to generate savings. In the three projects (PR2, PR5 and PR12) that failed despite intermediaries' contracting support, further analysis (Table F.1) shows that cost reduction also hinges on how effective and efficient the buyer's procedures are. Evidence from these projects suggests that additional testing of specifications, failure to consider through-life costs of implementing innovations, and the rising "cost-to-serve an order" when buying novel solutions increase the costs of innovation implementation e.g.: *"I then have to test again each of those [requirements] because you asked me […] and that testing costs a fortune." (Project Lead in project PR5, InnoDef)*. We thus conclude that intermediaries' specification-setting and contracting capabilities are not sufficient in themselves for generating cost savings – success in this respect also depends on well thought out buyer procedures.

5. Discussion

Our study generates theoretical insights regarding intermediaries' activities and underlying capabilities and key outcomes. Figure 1 presents a model, as a synthesis of our findings. Intermediaries create workspaces for R&D and experimentation, help to refine requirement definitions and de-risk novel solutions, support contracting, and facilitate solution implementation. Each of these activities is underpinned by capabilities that intermediaries exercise to compensate for shortfalls in the indirect capabilities of buyers and suppliers.

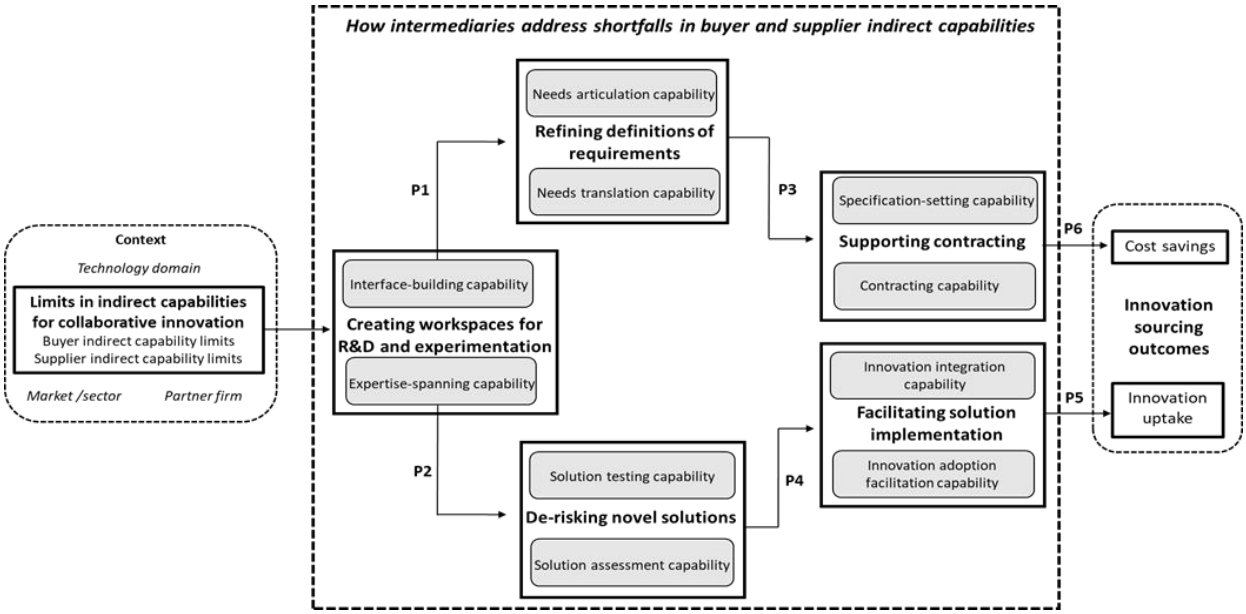

Figure 1: A Research Model of Innovation Intermediaries' Activities and Capabilities to Support Collaborative Innovation and their Impact on Innovation Sourcing Outcomes

Our empirical research and resulting model elaborate (Ketokivi & Choi, 2014) the indirect capabilities theoretical perspective in two ways. First, we introduce new types of indirect capabilities that buyer and supplier firms require to collaborate for innovation. Research on indirect capabilities has been mainly conceptual and highlights only certain elements such as interfacing and contracting (Spring & Araujo, 2014). We identify additional capabilities salient for collaborative innovation: a) those that buyers and suppliers need, but may be lacking, such as solution implementation and commercialization, respectively (see

Table 4), and b) those that intermediaries do exercise, namely expertise-spanning, needs articulation, needs translation, innovation integration, and adoption facilitation capabilities.

Second, we show how different types of indirect capabilities interrelate. Prior research has largely remained silent on how indirect capabilities such as boundary management, testing, and contracting relate to each another. Grounded on empirical research in the context of innovation intermediation, our model reveals certain relationships between indirect capabilities. For instance, we demonstrate that interface-building capabilities of intermediaries facilitate the articulation and translation of buyer needs. Similarly, intermediaries' expertise-spanning capabilities enable testing and assessment of suppliers' novel solutions.

5.1. Buyer and supplier indirect capabilities for collaborative innovation

Prior literature has stressed a set of capabilities that buying organizations must have to effectively access the technological capabilities of suppliers for innovation purposes (Legenvre & Gualandris, 2018; Narasimhan & Narayanan, 2013), including the capabilities of innovative small businesses (Ketchen & Craighead, 2021; Kurpjuweit et al., 2021; Zaremba et al., 2017). Our study shows that the indirect capabilities required to collaborate and to contract for innovation do not reside only within the buying organization. Rather, relevant capabilities are distributed along the supply network, notably in suppliers and in intermediaries.

Our empirical study offers insights with respect to indirect capabilities that suppliers require to access buyer knowledge, as a critical input for their innovation efforts (Alcacer & Oxley, 2014). Beyond supplier capabilities already identified in the literature, for instance the ability to understand buyer needs and processes (Kurpjuweit et al., 2018), we reveal other supplier indirect capabilities such as the ability to test novel solutions in context and generate evidence demonstrating their value, and capabilities related to commercialization and innovation integration. However, our study also shows that suppliers have limited capabilities

in these areas. Similarly, buyers experience indirect capability shortfalls regarding specification, supply market scanning, contracting and solution implementation.

These indirect capability limitations can at least partly be attributed to the fact that the capabilities necessary for collaborative innovation are context-specific. The two buying organizations had limited understanding of how to source innovations in certain technology areas (e.g., AI-enabled cyber intelligence and 3D-printing-enabled healthcare), which in turn restricted their ability to specify requirements reflecting the technological state-of-the-art, identify possible suppliers, and design suitable contracts. In other words, the MoD and the NHS seemed to "know less than they buy" (Flowers, 2007) in certain technological domains. By contrast, they are capable buyers when it comes to sourcing innovations in areas such as battle tanks and medicines, respectively. From a supplier perspective, the context-dependent nature of indirect capabilities was reflected in supplier (in)abilities to understand how the novel technology would add value to the buying organization's service processes, and knowledge regarding buyer-specific innovation integration and adoption requirements. Suppliers with no prior experience of defense and health markets faced significant indirect capability gaps in these areas, relative to suppliers already active in these markets. These findings challenge the view that capabilities needed to collaborate and contract for innovation are general-purpose, and thus transferable across technological and market settings (Legenvre & Gualandris, 2018). We find that the requisite indirect capabilities tend to be specific to the technology or market in focus, in addition to being partner-specific (Zaremba et al., 2007). Buyer and supplier shortfalls in such context-specific capabilities explain the role of intermediaries, who provide access to relevant sets of indirect capabilities on a contingent basis (Flowers, 2004).

5.2. Innovation intermediaries' contribution and innovation sourcing outcomes

Intermediaries create workspaces for collaborative R&D and experimentation by leveraging their capabilities in spanning expertise sets and building interfaces across organizational

boundaries (Spring & Araujo, 2014). These workspaces are both physical and conceptual. Intermediaries, through their projects, physically bring together all relevant stakeholders and organize access to requisite sets of technological and market knowledge. Knowledge requirements can differ depending on the problem at hand, and intermediaries are well placed to provide access to knowledge on an *ad hoc* basis by virtue of their expertise-spanning capabilities. Intermediaries also use their interface-building capabilities to conceptually match problems with possible solutions. An example of a conceptual workspace is InnoDef's "collaborative work environment", a platform where MoD employees, suppliers and other experts can exchange ideas and share project-specific knowledge. Through matching problems to potential solutions, it is intermediaries – rather than buyers or suppliers – who identify and articulate opportunities for innovation in the supply network (Ketchen & Craighead, 2020). Intermediaries' interface-building capabilities and work to match problems with solutions improves supplier understanding of buyer needs and helps buyers to translate their needs into what it is technologically feasible to ask for and achieve. Intermediaries therefore contribute to refined definitions of requirements by coordinating multiple buying organization's functions (Edler & Yeow, 2016) and involving suppliers and end-users. In sum, it is proposed:

Proposition 1: *Intermediaries' interface-building capabilities increase the likelihood of refining requirements through supporting buyers to translate their needs into what is technologically feasible.*

For the purposes of their projects, intermediaries are good at forming inter-organizational teams of experts, including end-users who are enrolled in field testing activities. These expertise-spanning capabilities of intermediaries contribute significantly towards testing and evidence generation, and therefore facilitate buyers and suppliers to assess novel solutions based on robust and objective data. We show that intermediaries both facilitate and undertake themselves R&D, demonstration, and evidence-gathering activities. Intermediaries thus

exercise their solution testing and assessment capabilities to help de-risk novel solutions. "Fear of failure" inhibits innovation in supply chains (Ketchen & Craighead, 2020), and this is also pertinent in the public sector settings we studied, where procurement professionals tend to be risk averse. From a supplier viewpoint, intermediaries' work to define the innovation's value for the buyer reduces suppliers' perceived risk of failure, thereby incentivizing further supplier investment and development effort. It is thus proposed:

Proposition 2: *Intermediaries' expertise-spanning capabilities increase the likelihood of de-risking novel solutions through supporting buyers and suppliers to test, assess and generate evidence about solutions under consideration.*

We also show that intermediaries' work to articulate problems and help buyers to translate their needs into what is technologically possible contributes significantly towards intermediaries' provision of contracting capabilities (Spring & Araujo, 2014), particularly in relation to the development of industry-informed specifications as key inputs into the contracting process. Stated differently, intermediaries' work to help buyers refine their requirements, considering technological and supply market knowledge, supports contracting and helps buyers to craft more intelligent specifications. We thus show how intermediaries address limits in buyers' contracting capabilities. In sum, it is proposed:

Proposition 3: *Intermediaries' assistance in refining buyer requirements supports contracting, as it increases the likelihood of buyers' developing informed specifications.*

Intermediaries help to de-risk novel solutions by supporting testing, assessment, and evidence generation regarding the technical, commercial, and organizational feasibility of innovations. We show that such work contributes significantly towards intermediaries' facilitation of solution implementation. Intermediaries' testing and assessment capabilities produce rich insights regarding requirements and possible barriers to integrating supplier innovations into the buyer's existing service processes. We complement prior research

(Alcacer & Oxley, 2014; Kurpjuweit et al., 2018) by showing how suppliers can leverage their relationships with intermediaries to access testing opportunities and gain insights regarding any required adaptations to ensure smooth integration of their innovations. It is thus proposed:

Proposition 4: *Intermediaries' assistance in de-risking novel solutions facilitates solution implementation, as it increases the likelihood of buyers' and suppliers' learning about specific innovation adoption and integration requirements.*

The findings show that intermediaries' solution implementation capabilities have a positive influence on innovation uptake, as intermediaries analyze and explicate innovation integration requirements and facilitate adoption by educating suppliers and helping them to pre-empt any barriers to the adoption of their solutions. We also find that while intermediaries' specification-setting and contracting capabilities are needed to achieve cost savings, they are not sufficient in themselves. Cost reduction also hinges on well-crafted buyer procedures in terms of testing specifications, costing, and ordering. We therefore propose:

Proposition 5: *Intermediaries' capabilities and activities to facilitate solution implementation are positively related to the buyer's uptake of supplier innovations.*

Proposition 6: *The impact of intermediaries' capabilities and activities to support contracting on buyer cost savings is contingent on effective and efficient buying procedures.*

6. Conclusions

6.1. Theoretical implications and contributions

We contribute to research on supplier-enabled innovation (e.g., Narasimhan & Narayanan, 2013; Yan et al., 2020) by providing theoretical insights regarding intermediaries' activities and underlying capabilities, and their impact on innovation sourcing outcomes. Innovation intermediaries represent a class of actors that, strictly speaking, do not belong to the supply network in that they are neither buyers nor suppliers of products or components (Kumar et al., 2020) – other examples of such entities include NGOs and public agencies designing and

implementing policies (Pagell & Wu, 2009; Selviaridis & Spring, 2022). Yet, we show that innovation intermediaries constitute important nodes that exert influence on the supply network and facilitate the innovation process. Our qualitative research and resulting model (Figure 1) elaborate (Ketokivi & Choi, 2014) the indirect capabilities theoretical perspective by introducing additional types of indirect capabilities for collaborative innovation and showing how these capabilities interrelate (refer to Discussion).

In addition, we contribute to the literature on innovation intermediaries by showing unexplored capabilities underpinning intermediaries' activities. The literature in this area emphasizes the multiple roles and activities of intermediaries but – with a few exceptions – has paid less attention to their underlying capabilities such as boundary-spanning, matchmaking, and technology evaluation capabilities (Alexander & Martin, 2013; Tran et al., 2011). We extend this literature by identifying other critical capabilities for intermediation including innovation integration and innovation adoption facilitation. Our study also extends the specific literature on the role of intermediaries in open innovation (e.g., Katzy et al., 2013; Ogink et al., 2023) by showing additional activities in this context: refining definitions of requirements, de-risking solutions, and supporting contracting. We thus suggest that intermediaries can contribute to broader open innovation mechanisms (Ogink et al., 2023), for instance collaborative testing and assessment of prototypes as well as risk reduction.

More broadly, the study demonstrates the utility of the indirect capabilities theoretical perspective (Loasby, 1998) in supplier-enabled innovation research, and in OSCM scholarship in general. This perspective complements the conventional view that focal organizations must be good at planning and coordinating internally and collaborating with supply network counterparts to manage relatively stable material and information flows (McCone-Sweet & Lee, 2009). Given fast technological change and specialization trends, it is imperative that focal organizations are also competent at gaining *temporary access* to complementary capabilities

distributed in inter-organizational networks, which extend beyond existing suppliers and customers (e.g., to start-ups as prospective suppliers) and may include also valuable horizontal links (e.g., to expert organizations). Furthermore, because the requisite indirect capabilities can be specific to technologies or sectors little known to the focal firm, the ability to link to the indirect capabilities of others, as and when needed, is imperative for specifying requirements, exploring solutions, and contracting for innovation. Using an intermediary to access context-specific indirect capabilities may thus be an efficient way to source innovations in supply networks characterised by fast technological and market change. Focal buying organizations no longer need to be knowledgeable in every technology area, or when dealing with suppliers with peculiar features (e.g., start-ups). Although focal firms still require indirect capabilities to access and use intermediaries' services, accessing innovation through intermediation shifts the requirement to more general-purpose indirect capabilities, hence reducing the need for focal firms to "know more than they do" (i.e., develop broad technological capabilities internally). An indirect capabilities lens is relevant in other contexts too: for instance, in crisis settings where creative responses to supply chain disruptions require an ability to quickly assess and make use of the capabilities of other firms (Ketchen & Craighead, 2021; Yan et al., 2022).

6.2. Managerial and policy implications

A focus on indirect capabilities suggests that buyers and suppliers must develop certain sets of indirect capabilities to be able to access innovation intermediaries' capabilities. This has implications for managers of both buying organizations and suppliers regarding how they can effectively use intermediation support. For buyers, relevant indirect capabilities include an outcome-based approach to the articulation of their requirements, an ability to forestall technological or supplier lock-in risks linked to intermediation, and the ability to independently assess the organizational readiness to adopt novel solutions. For suppliers, important indirect capabilities include the ability to elicit relevant resources (e.g., information and connections)

from intermediaries and communicate to them what buyer-specific knowledge is required. Suppliers must also be able to assess and prioritize opportunities that intermediaries identify on their behalf, for example based on analysis of solution customization requirements. An ability to manage relationships with intermediaries is equally important for both buyers and suppliers – key aspects include defining innovation objectives and resource investments and exploiting the outputs of intermediary-initiated innovation projects.

From a public policy perspective, we show that innovation intermediation can be an effective tool (Spring et al., 2017) to support collaborative innovation and drive innovation uptake in supply chains. However, intermediaries provide only temporary access to indirect capabilities, which raises questions regarding a) the ability of (public) buyers to build long-term capacity internally, and b) what such capacity should consist of in the first place. Buyer concerns about losing the requisite know-how to source innovations from suppliers may be less relevant in cases of fast-spin technologies and dynamic supply markets where requirements and solutions are in flux, and where intermediation adds value. In such cases, it is more important that buyers such as the NHS are capable of dealing with intermediaries. Policies complementary to intermediation would be useful to this end: aligning public procurement and innovation policy goals and institutionalizing metrics to manage intermediaries' performance.

6.3. Generalizability and boundary conditions

Our findings are generalizable to settings with similar characteristics to defense and healthcare sectors. We identify two boundary conditions – referring to the "who", "where" and "when" aspects of theory development (Busse et al., 2017; Whetten, 1989) – to discuss the generalizability of our model and propositions. These conditions are a) the institutional context within which intermediaries operate, and b) the number of buyers vis-à-vis the number of suppliers in the supply network. In the defense and healthcare sectors we studied, innovation intermediaries help to tackle deficiencies in the institutional context within which collaborative

innovation occurs. Such deficiencies matter because they underpin capability limitations of both buyers and suppliers. For instance, large buyers such as the NHS tend to work with established suppliers; they are often reluctant to engage with innovative small suppliers lacking a proven track record. This means that buyers have underdeveloped processes for identifying new suppliers who specialize in emerging technology domains. In addition, rigid procurement procedures and conservative norms discourage early and close interactions which help suppliers better understand the buyer's needs and test and refine their novel solutions.

These institutional constraints are, however, not unique to defense and healthcare; they are also relevant in private sector supply networks where buyers are for-profit firms. Consider, for instance, the automotive industry. Trends of electrification, autonomous driving, and "connected vehicles" increase the reliance of powerful automotive OEMs on non-conventional suppliers (e.g., for batteries, autonomous systems, and cyber security solutions), some of which are SMEs or startups. Similar to defence and healthcare, automotive OEMs (as buyers) and these innovative suppliers can find it difficult to collaborate, for instance because buyers have limited knowledge of these "new" suppliers, or lack customized processes to select and assess them (Zaremba et al., 2017); or because suppliers do not understand what is involved in working with large, multi-layered buying firms and have limited knowledge of their market context and needs. Hence, in private-sector settings too, intermediaries help to mitigate deficiencies in procedures, rules and norms, and support buying firms and suppliers to improve their collaborative innovation capabilities. An example of innovation intermediary organizations founded by the government to support private sector buyers and suppliers is the High Value Manufacturing Catapult in the UK[3]. The intermediary has supported, for instance, Jaguar Land Rover, an automotive OEM, to accelerate its electric vehicle battery development programme through collaborative R&D and battery experimentation activities.

[3] The High Value Manufacturing Catapult is a UK government-initiated intermediary who brings together buyers, suppliers and other experts to develop and implement novel solutions in various manufacturing technology areas (Spring et al., 2017).

Conversely, in public and private sector settings where the institutional context is more conducive to collaborative innovation – for instance, because procurement processes are innovation-oriented, friendly to innovative small firms, and encourage early and close buyer-supplier interactions – the activities of intermediaries we unveiled may be less relevant.

Our study focused on two sectors where innovation intermediation occurs between a sole buyer (quasi-monopsony) and multiple suppliers. However, the institutional deficiencies outlined above are similarly applicable in settings, including private-sector ones, featuring a small set of buyers (oligopsony) who are still large, powerful, and often inflexible and slow-moving. Examples include aerospace and energy contexts. It follows that the intermediaries' activities and capabilities we identified are potentially transferable to supply networks involving a small set of powerful buyers. Nevertheless, our findings may be less applicable in contexts where intermediation occurs between a (very) large set of buyers and of suppliers – in such industries (e.g., see apparel or design), the high level of market competition increases the need for buyers and suppliers to innovate and develop new technological capabilities. However, intermediary capacity constraints and high set-up costs may render large-scale workspaces for R&D and experimentation, solution testing and assessment less feasible. In such contexts, simpler forms of intermediation likely prevail – for instance, connecting buyers and suppliers of novel solutions through digital platforms (Colombo et al., 2015).

6.4. Limitations and future research

The research concerned intermediaries operating in defence and healthcare sectors which have different regulations and governance rules, potentially limiting comparative analysis. In spite of these differences, though, we identified a set of intermediaries' activities and capabilities that was common across the cases. Further research in private sector supply networks, especially those featuring large sets of buyers and of suppliers, is required to build a more encompassing theory of how intermediaries support collaborative innovation. Our study did

not cover all forms of intermediation (e.g., digital platforms), and especially those founded by for-profit entities, as opposed to by governments. We also did not compare collaborative innovation projects initiated by intermediaries with those lacking intermediation support. Future research should include other types of intermediaries, studying also the internal structures, resourcing decisions, and processes underpinning their support services. It could also examine performance effects using large-scale samples of intermediary projects and analyzing innovation sourcing outcomes for collaborative innovation projects with and without intermediary involvement. Beyond the context of innovation intermediation, further empirical research is needed to explore the indirect capabilities that might be salient in other supply chain settings and for purposes other than innovation.

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APPENDIX A: The Interview Guide

Background questions [all interviewees]

- What is your formal job description and key role within the organisation?
- Please provide a brief overview of your organisation

Questions focusing on innovation intermediaries [InnoDef and InnoMed]

- What is the remit and strategic objectives of InnoDef /InnoMed as an organization?
- Overview of InnoDef /InnoMed's services? Any focus on specific technologies or defence /health application areas?
- Overview of organizational structure and key business processes?
- Key challenges facing the MoD /NHS with respect to innovation sourcing and collaborative innovation with suppliers.
    - Buyer challenges? What causes them?
    - Supplier challenges? What causes them?
- What is InnoDef /InnoMed good at? Key expertise and capabilities underlying your services?
- How do you go about supporting the MoD/NHS and its suppliers to collaborate?
- Can you tell me about your innovation projects? What does a typical project look like?
- Typical examples of projects your organisation is currently running?
- What are the main outcomes and impacts of the support you offer? Any notable examples of successful projects?

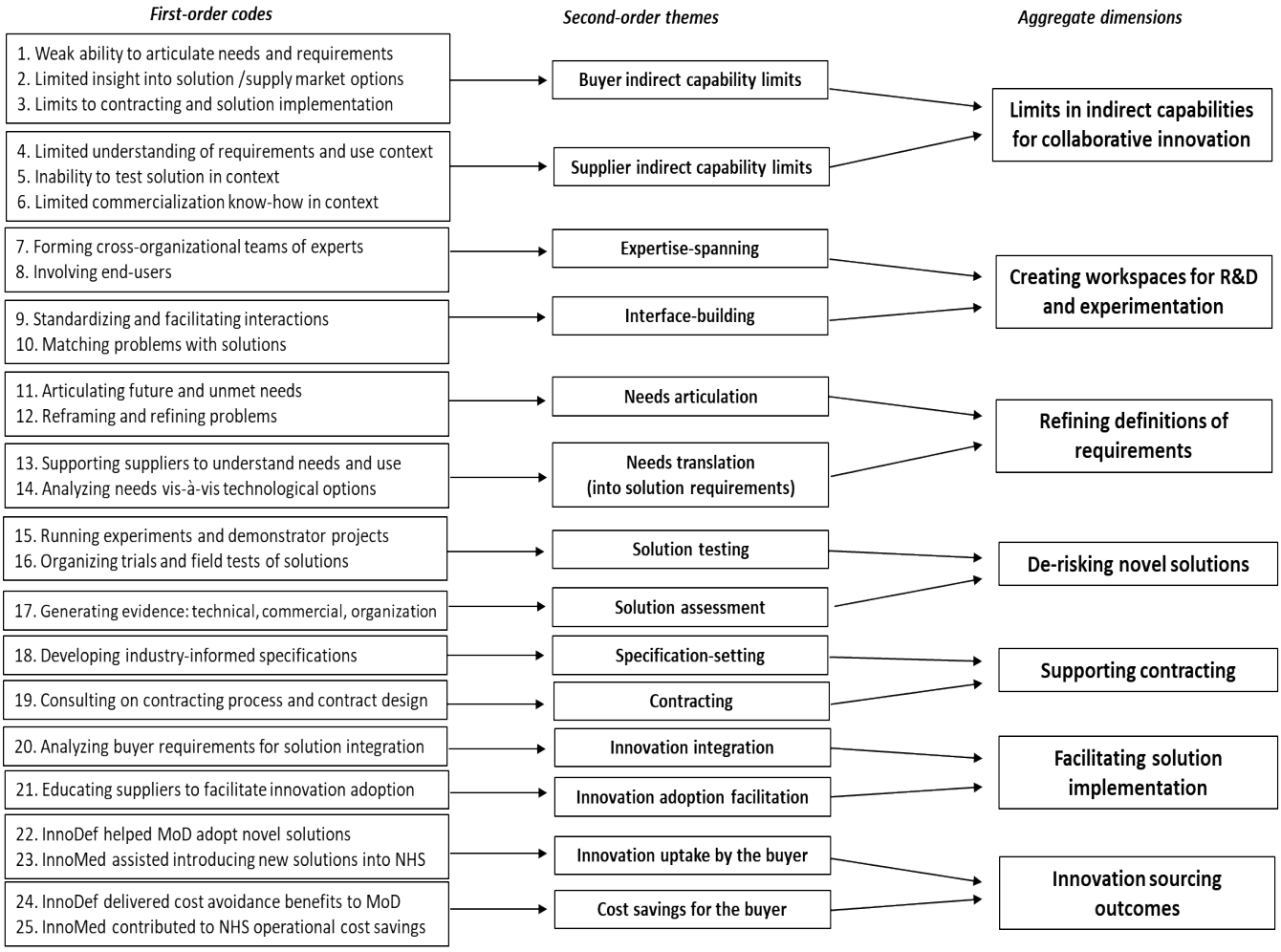
Questions focusing on buying organizations [MoD and NHS]

- Overview of the MoD /NHS procurement processes and supplier relationship management.
- Innovation sourcing at the MoD /NHS: rationale, key objectives, and collaboration with suppliers
- Key routes for innovation sourcing in the MoD / NHS hospitals? How do you typically work with suppliers to source an innovative product /service?
- To what extent are MoD /NHS procurement processes and practices conducive to innovation?
- Key challenges facing MoD /NHS procurement professionals in relation to innovation sourcing and supplier collaboration for innovation?
- Any specific challenges when dealing with small innovative suppliers?
- Capabilities required to collaborate with suppliers and contract for innovation? To what extent are these capabilities well developed within your organization?
- How do you perceive the role and contributions of InnoDef /InnoMed in supporting your work?
- Key benefits from using the services of InnoDef /InnoMed?
- Key challenges regarding working with InnoDef /InnoMed?
- Outcomes of InnoDef /InnoMed projects? Any example projects you would like to share?
    - Innovation adoption and cost efficiencies from implementing supplier innovations?

Questions focusing on suppliers

- Brief description of the new product /technology that you seeking to sell to the MoD /NHS.
- Key challenges of collaborating with the MoD /NHS as a buying organization?
- Capabilities required to collaborate with the MoD /NHS for innovation? How well developed are these capabilities within your organisation?
- Why did you decide to get involved in the InnoDef /InnoMed project? Please provide an account of the engagement and its key activities and outcomes.
- How does InnoDef /InnoMed support your company? What types of support you have received?
- How do you benefit from engaging with InnoDef /InnoMed?
- What do you perceive as the key roles and contributions of InnoDef /InnoMed, more generally?
- How successful has your involvement in InnoDef /InnoMed been? Any example projects?
    - Has your innovation been adopted? Key buyer benefits from using your innovation?

APPENDIX B: Data Coding Structure



APPENDIX C: The Data Coding and Analysis Process

The qualitative data coding and analysis process involved five key steps, which are described in detail in the following.

Step 1
The aim of this initial step was to gain a preliminary understanding of collaborative innovation between buyers and suppliers in the specific context of the UK defence and healthcare sectors, and of the role of innovation intermediaries in this respect. The analysis was primarily exploratory and focused on the key challenges facing buyers and suppliers when seeking to collaborate for innovation purposes, and how innovation intermediaries such as InnoDef and InnoMed, respectively, support buyer-supplier collaboration. To explore these issues, we decided to pick six representative interviews and analyze them in full: for the InnoDef case, we selected an interview with the Managing Director of the intermediary, the MoD DE&S's Innovation Lead, and a defence supplier manager. Similarly, for the InnoMed case we anayzed an interview with InnoMed's Chief Operation Officer and Assistant Commercial Director, a Head of Procurement at a major NHS hospital, and the founder and CEO of an SME supplier firm. Analysis of these interviews offered rich insights regarding collaborative innovation challenges and intermediaries' services and value added. It generated 32 first-order codes, which stayed close to the lingo and terminology that interviewees used.

Step 2
During this step, we sought to better understand the origins or causes of the challenges reported by buyers, suppliers and the two intermediaries' managers in relation to collaborative innovation in the UK defence and healthcare sectors. We also dug deeper into intermediaries' expertise and capabilities, business models, how they went about helping buyers and suppliers, and performance impacts of their support. During this step, we analyzed six additional interviews with intermediaries, buyers and suppliers applying the same logic as in Step 1. We also took into account a sample of ten of the most relevant organizational documents, such as intermediaries' annual reports and a selection of MoD's case studies of InnoDef projects. This more extensive coding and analysis process, albeit still largely preliminary, provided further insights especially regarding the sources of challenges facing the MoD, the NHS, and their respective suppliers. Key sources of challenges that featured prominently were knowledge and capability gaps of buyers and suppliers. We also uncovered deficiencies in regulatory frameworks; procurement rules and norms impeding collaborative innovation; and procedural and governance barriers (e.g., silo mentality in the public sector). This coding step led to an increase of first-order codes (48 in total), compared to Step 1.

Step 3
We analyzed all remaining interviews and documents, seeking also to understand which of the issues linked to the challenges we uncovered in Step 2 were the most prevalent in each sector. Analysis of the total set of interviews led to the conclusion that the key underlying issue, across the two cases /sectors, was knowledge and capability shortfalls of buyers and suppliers. We distinguished between buyer-specific capability limitations and supplier-specific capability limitations, for instance a weak ability to define needs and requirements and inability to test novel solutions in real-life (buyer) contexts, respectively. Accordingly, we also re-examined our data to identify specific forms of expertise (know-how) and capabilities that intermediaries contributed to address buyer and supplier limitations, as well as how intermediaries influenced innovation adoption and cost efficiency outcomes for the buying organizations.

At this stage, we sought to reduce our first-order codes to a more manageable set reflecting the above insights we gain, eventually deriving a core set of 25 first-order codes (see Appendix B). During this process, we decided to subordinate the codes regarding deficiencies in rules and norms in the UK defence and health sectors because these issues were already largely reflected in buyer and supplier capability limitations. For instance, both the MoD and NHS seem to have weak abilities in identifying new suppliers who specialize in emerging technology domains. This limitation is closely linked to the fact that both buying organizations prefer collaborating with established suppliers and are often less willing to work with new, innovative suppliers who lack market reputation.

We also decided to drop certain codes because they were unrepresentative of the main issues we observed in the cases in relation to our research focus and question. For instance, we dropped the first-order code "facilitating health economics analysis" because it was case-specific (InnoMed) and far from representative of the way the two intermediaries seek to source and use third-party expertise to include in their projects. In another example, we dropped the code "analysis of interoperability of IT-based innovations" when it became evident that this type of know-how was not representative and rarely featured in the two intermediaries' projects. On the other hand, we opted to retain codes which were not equally prevalent across the two cases (e.g., "educating suppliers to facilitate innovation adoption") when these were deemed theoretically important e.g., because they were directly influencing the innovation sourcing outcomes under investigation.

Step 4

During this step, and in line with the key insights we gained in Step 3, we decided to consult the capabilities literature and more specifically borrowed the "indirect capabilities" perspective as our chosen theoretical lens, because it fitted well our empirical observations and initial analysis. Accordingly, we re-examined and re-organised our first-order codes into a smaller set of theory-informed, second-order themes using an axial coding approach. Section 3.3 in the main body of the manuscript provides details of this process, during which we used indirect capability types from prior literature to derive key second-order codes focusing on intermediary capabilities such as "expertise-spanning", "interface-building", "testing", and "contracting".

Step 5

Following Gioia et al. (2013), in this last step we sought to group our reduced set of second-order themes into key aggregate dimensions. Specifically, we grouped second-order themes referring to intermediaries' capabilities into five key activities that intermediaries undertake to support buyers and suppliers to collaborate for innovation. We also created aggregate dimensions reflecting buyer and supplier indirect capability limits and the innovation sourcing outcomes of intermediaries' support. Section 3.3 in the method section of the manuscript offers further details. Appendix B presents the resulting data coding structure.

APPENDIX D: Within-Case Analysis

Table D.1: InnoDef case data and analysis

Key constructs	Sub-constructs (first-order codes)	Example issues/projects/artefacts	Indicative interview quotes /document excrepts
Limits in buyer and supplier indirect capabilities	**Buyer weak ability to articulate needs /requirements:** MoD rigid 'specification of work' statements do not consider the art of the possible or allow for integration of the technological state-of-the-art. **Buyer limited insight into solution /supply options:** MoD lacks understanding of what industry has to offer in specific domains, and how the need or problem could be solved. **Buyer limits to contracting and solution implementation:** MoD limited ability to design contracts conducive to innovation, and to help accelerate solution integration **Supplier limited understanding of needs and use context:** Defense suppliers lack in-depth insight of what MoD units need, now and in the future. **Supplier inability to test solution in context:** Defense suppliers limited opportunities to test solutions in use settings. **Supplier limited commercialization know-how in context:** Defense suppliers (especially SMEs) seeking to understand what business model would fit MoD's approach to procurement	Over-specification of requirements impedes innovation and increases costs MoD procurement professionals unclear which (combinations of) technologies best fullfil need Integration of novel solutions into MoD requires early analysis across 'Defense Lines of Development'; this is often lacking Supplier limited understanding deters investment into solution development	• *"They [MoD DE&S] tend to write requirements which are very, very detailed and, of course, the manufacturer, the maker, then has to demonstrate and it really takes away any opportunity for innovation" (Lead of project PR4, InnoDef).* • *"The standard process of acquisition does not readily or sufficiently early take into account of 'the art of the possible' which would avoid the unknowing 'baking in' of requirements that are unachievable […] nor the standard process have ready mechanims for accomodating technology opportunities in a 'bottom-up' fashion" (InnoDef "Continuous capability evolution", p. 8-9).* • *"Until you've got your head around all those other [technology] developments it's quite difficult…there are examples over the years of buying helicopters with … you know, American technology but nobody had done the training, nobody talked to the regulators about whether or not they could put them through our heli-readiness regime, not the American one. They've been in the hangar for years" (Innovation Lead, DE&S Technology Office).* • *"By involving industry [suppliers] in projects, industry develops a much better understanding of what the MoD really needs" (Technical Director, InnoDef).* • *"If you [supplier] push the technology ahead of everything else all you've got is this fantastic solution that we don't know quite how to take advantage of" (Innovation Lead, DE&S Technology Office).* • *"[…]we're just too small and too risky for £30-40 million [MoD] programmes. Even the paperwork, the product support paperwork, the after-support paperwork, would probably consume the whole company's resources (CEO, SME supplier).*
Creating workspaces for R&D and experimentation	**Forming cross-organizational teams of experts:** InnoDef brings together multiple experts from defense industry, MoD, academia, and other organizations (e.g., consultancies) to work on a defined project **Involving end-users:** InnoDef actively seeks to connect defense suppliers to key users of the solution (e.g., Air Force and Army officers) and others such as regulatory affairs experts **Standardizing and facilitating interactions:** InnoDef has established IT-based (virtual) collaborative work spaces, a standardised intellectual property framework, and a set of operating principles and procedures which facilitate cooperation and interactive learning. **Matching problems with solutions:** InnoDef fosters MoD-supplier interactions to identify and discuss the "problem-solution space"	InnoDef core management team seeks to select the best people to work in each project ('Best-athlete approach') InnoDef's principles /norms for collaboration and the special-purpose intellectual property (IP) arrangement InnoDef's Generic Approaches, Visualization Techniques templates and common database for projects	• *"A project team is put together and the inputs and outputs of the project are defined. The project team consists of experts from various sources: MoD, industry and academia. A 'best athlete' approach is followed for the formation of the project team, meaning choosing the most suitable individuals for a specific project" (Managing Director, InnoDef).* • *"I would normally go out to industry and find the best ninjas, and I use that word a lot. I'd go and find the best people to make this project team […]I needed the best people available to be able to work on the task" (InnoDef Project Manager responsible for project PR3).* • *"The [InnoDef] model is to work quite closely with individuals [military end users]" (Lead of project PR4, InnoDef).* • *"The [InnoDef] Way Principles are followed by all projects and underpin the provision of informed impartial advice. The set of [InnoDef] Way Principles is grouped under six key headings […]: Engagement, Exploitation, Consistency, Quality, Impartiality, Independent Assurance" (excrept from "The [InnoDef] Way: A quick reference guide", p.3).* • *"We have a fairly unique way of handling intellectual property which is highly conducive to exploiting the outputs […] we're able to support that because the foreground IP is owned by MoD. And there are mechanisms to preserve background IP and people [suppliers] can bring background IP to the table. It's all within an existing framework, so we understand the rules that are going to be applied to handling their own IP." (Technical Direct, InnoDef).*
Refining definitions of requirements	**Articulating future and unmet needs:** InnoDef work to help identify and articulate unmet needs and requirements of various MoD units (as end users).	Example: requirements for future aircraft refueller system (project PR6) Example: refining requirements for pilot sensory experience	• *"The [InnoDef] project team engaged with MoD stakeholders to refresh and validate the refuelling capability requirements on the basis of objective evidence" (MoD case study, project PR6).* • *"We were able to identify that actually for the particular training context we were talking about, you could get away with a two-degree of freedom. So that's going to save you loads of money and actually exploitation then is really easy. It just means the customer [Air Command] knows he's*

	Reframing and refining problems: InnoDef work to refine problem definitions based on in-depth examination of needs and requirements of end users. **Supporting suppliers understand needs and use in context:** InnoDef projects allow parctipating suppliers to gain insights into real needs and solution fit to military operating context **Analyzing needs vs. technological options:** projects bring together MoD procurement, users and suppliers to discuss what is technically and commercially-feasible to achieve given needs and cutting edge technologies.	during training for the flight simulator solution (project PR1)	*going to acquire something that actually is going to be cheaper and simpler than the thing he was going to potentially have to acquire before that" (Technical Director, InnoDef).* • *"[…] from the industry perspective they [suppliers] gain influence, they gain understanding and, in some cases, they gain influence and understanding where they wouldn't have even got a seat at the table because they're so small (Delivery Director, InnoDef).* • *"Previous assumptions had suggested that helicopter simulators must have full motion platforms (6 Degrees Of Freedom) in order to provide effective aircrew training. [InnoDef] conducted a short, innovative and objective assessment of the role of motion cueing in helicopter training through a mixture of qualitative and quantitative analysis…the aim was to determine whether it was necessary to have a full motion platform or whether a less expensive option was feasible, without effecting the efficacy of training" (MoD case study, project PR1).*
De-risking novel solutions	**Running experiments and demo projects:** InnoDef managers design and execute experimental work and concept demonstrators using suitable techniques e.g. agile approach **Organizing trials and field tests:** InnoDef managers help to set up field tests of solutions with military end users **Generating evidence – technical, commercial and organizational:** experiments, demonstrators and field tests generate evidence, which forms the basis for assessment of solutions as well as analysis of requirements for integration into existing MoD systems and operating processes	Experiments and concept demonstrators designed by InnoDef in projects e.g. PR2 and PR3. Project reports offer impartial evidence regarding the technical, commercial and organizational viability of solutions. Testing /assessment emphasizes identification of risks of solution not being fit for purpose	• *The principal outcomes were to de-risk use of [training system] as an enduring solution for Army training and to de-risk the development of training systems to meet the needs specified in a number of specified high-cost MoD C4ISTAR and training projects (Project PR4 document, InnoDef).* • *[…] we would then effectively get the ball rolling on how that [problem] was going to be solved. So, we would look to suggest what the likely resource impact would be for the MoD, how long it might take, what the risks were (Delivery Director, InnoDef).* • *It's inappropriate for [InnoDef] to tell MoD what to do. So it's more common that we will present options and arguments with the evidence so on. If you carry on down this route, the benefits would be this. Disadvantages would be also there in some way. (Technical Director, InnoDef).* • *"We feel one of the things which [InnoDef] does is it's a much more objective view, sometimes, of the conditions of taking forward innovation. So, you know, you're not getting one person's opinion…of how they would do it if they were asked to supply it. You get much more of an objective and industry-wide view" (Innovation Lead, DE&S Technology Office).*
Supporting contracting	**Developing industry-informed specifications:** InnoDef project outputs and related evidence is used to develop supplier-informed specifications of requirements cutting out unecessary cost drivers and enabling innovation **Consulting on contracting process and contract design:** InnoDef projects offer insights into suitable approach to tendering, contract design and commercial frameworks.	Example: Mission-critical tranining project (PR4) led to refined specifications Example: introduction of novel contracting approach for the procurement of the open source intelligence solution (PR2)	• *"The real requirements were developed and understood by both the users and industry developers as the two communities worked together day to day on the training events […] the InnoDef] demonstrators showed an improved requirements model, similar to cardinal points but in outcome terms (InnoDef case study, project PR4).* • *"As a result of [InnoDef] developing and demonstrating the innovation process, the MoD has taken a new approach to procuring this key capability and ensured that the solution will continue to incorporate the latest technology, avoiding the risk of becoming obsolete given the rapid pace of technology change (MoD case study, project PR2).*
Facilitating solution implementation	**Analyzing buyer requirements for solution integration:** InnoDef assists in analyzing requirements across 'defense lines of development' and barriers to solution integration. **Educating suppliers to facilitate innovation adoption:** suppliers taking part in InnoDef projects develop insight into technical and commercial adjustments to drive MoD uptake	Example: systematic analysis of possible barriers to IT solution integration (PR3)	• *"[InnoDef'] role in that is giving a much more balanced view to the customer, it's giving us a much better, balanced view of the market conditions and supply chain and the hurdles you have to overcome" (Innovation Lead, DE&S Technology Office).* • *"Lessons and insights were captured […] and the design [of the IT service solution] was iterated accordingly. In parallel, a commercial investigation was conducted; this was wide-ranging and examine the procedural and cultural issues and blockers of rapid acquisition of complex commoditised services" (excrept from the InnoDef case study for project PR3).*
Innovation sourcing outcomes	**InnoDef impact on innovation uptake**: 131 projects led to uptake of innovations and early integration of technological solutions into military operations within the period 2013-2018. These include the six projects studied in detail. **InnoDef impact on cost savings**: estimated cost avoidance £1.89bn (self-reported) vs. £140m MoD investment. Cost savings identified in three projects we examined.	Projects PR1-PR6 ; More generally, InnoDef aided MoD uptake through its projects Projects PR1, PR3, PR4 ; More generally, InnoDef delivered cost avoidance benefits to MoD	• *"the MoD and the intelligence community [being] safely able to exploit a vast and untapped information resource, in real-time […] the MOD has taken a new approach to procuring this key capability and ensured that the solution will continue to incorporate the latest technology" (MoD Case Study, PR2).* • *"A fit-for- purpose training system for [helicopter] can be delivered within tight financial constraints. Immediate and consequent through life savings from this short, comprehensive [InnoDef] study represent an order of magnitude reduction in cost to the MoD over previous training solutions (MoD case study, project PR1).*

Table D.2: InnoMed case data and analysis

Key constructs	Sub-constructs (first-order codes)	Example issues/projects/artefacts	Indicative interview quotes /document excrepts
Limits in buyer and supplier indirect capabilities	**Buyer weak ability to articulate needs /requirements:** NHS procurement professionals have limited capacity to be involved in processes for identifying unmet needs **Buyer limited insight into solution /supply options:** NHS procurement community lacks capability and capacity to continuously scan and assess the supply market for new technologies /solutions **Buyer limits to contracting and solution implementation:** NHS contracting processes and practices discourage uptake of innovations, especially those developed by innovative SMEs **Supplier limited understanding of needs and use context:** suppliers (especially SMEs) unable to gain access and engage closely with NHS providers such as NHS hospitals **Supplier inability to test solution in context:** suppliers limited in their ability to test their novel solutions against NHS requirements and to generate clinical evidence **Supplier limited commercialization know-how in context:** many suppliers lack knowledge of how they should promote and sell their solutions to the NHS market (e.g., what business model would fit well the NHS's operating practices)	NHS procurement professionals are hardly involved in identifcation of future needs and innovation; focus is on short-term, savings-oriented targets NHS procurement professionals have limited bandwith to perform horizon scanning activities and identify new suppliers NHS procurement professionals not attuned to working and contracting with small suppliers Small suppliers have limited ability to engage with the NHS to test solutions and generate evidence	• *"If you were allowed to not have a target for a couple of years you could focus your efforts on the longer term strategy, on the bigger picture around reducing bed days and better outcomes for patients […] If you could get away from the annual savings targets on knocking a few pence off a syringe, or whatever, then that would be better but whilst we've got these annual targets… that's the priority" (Head of Procurement, NHS hospital).* • *"Through our engagement, try and demonstrate to the NHS it's the art of the possible, but commissioning and procurement is still quite a traditional practice. It's done by generalists and it tends to be done on a basis of what they did last year or the year before […] by getting into the discussions and providing visibility to the innovations we're providing bandwidth and horizon scanning for the people that make decisions around commissioning and procurement and transformation" (Assistant Commercial Director, InnoMed).* • *"Now, if you [NHS] are innovative and if you're piloting new ideas then you have to move away from 'who's done it before?'[to] 'We'll work with you to make it work'. And that's not usually in their [NHS] psyche. They all work on evidence. Therefore, you see a lot of SMEs really struggle to penetrate this marketplace" (Healthcare Director, SME supplier in project PR8).* • *"[…] it's probably down to the process in terms of timescales for procurement. So, if we have a contract for a product or we've purchased a product or there's a framework that we buy that product from, it's that window while a new device is locked out, that's the only problem" (Head of Procurement & Commercial Finance, NHS hospital).* • *"[…] the frustration of trying to engage with [NHS] Trusts. Trying to speak to the right people […] what we need to do, is talk to senior people who will see the value of what we're doing" (Managing Director, SME supplier in project PR7).*
Creating workspaces for R&D and experimentation	**Forming cross-organizational teams of experts:** InnoMed spans boundaries connecting senior decision makers at hospitals, (SME) suppliers, and various specialists (e.g., health economists and manufacturing experts). **Involving end-users:** InnoMed connects SMEs to clinicians and other relevant experts (e.g., digital health) and facilitates dialogue **Standardizing and facilitating interactions:** InnoMed mainly seeks to facilitate meetings and events that enable dialogue between buyers, suppliers and other experts **Matching problems with solutions:** InnoMed actively seeks to match NHS needs with industry's technological solutions	Using external manufacturing experts to help assess the foldable stretcher solution (project PR10) InnoMed introduces SME solutions to clinicians and other end users such as hospital IT administrators (e.g., projects PR7 and PR8	• *"[InnoMed's Commercial Manager 1] has been our primary contact and he's been able to give us some advice about getting the manufacturing costs down, getting away from the current manufacturer. And introducing us to a variety of people just to get their views on would it be suitable or is it not suitable. And if it is suitable would you like anything doing to it that would make it more suitable? He's been sort of like a point of referral for us, really" (Managing Director, SME supplier in project PR10).* • *"We've had events whereby hospital managers have been able to present their ideas, SMEs to go yes, I can help you with this or yes, I can help you with this" (Commercial Manager 3, InnoMed).* • *The opportunity for our local businesses is, if we can get them to be purchased and commissioned by the local NHS then there's a chance that NHS England would benefit from their adoption. The [3D-printing supplier], actually you could argue you could do that in every hospital but we need the evidence base to justify the investment in that (Assistant Commercial Director, InnoMed).*
Refining definitions of requirements	**Articulating future and unmet needs:** InnoMed works with hospitals, CCGs and GPs to shape and articulate unmet needs and requirements, both regionally and nationally. **Reframing and refining problems:** InnoMed works to analyse in-depth and revisit requirements. It also examines how available technological solutions could be adapted to meet needs, or how they could be transferred to meet needs in other care settings (e.g., mental health and primary care).	Identifying efficiency requirements in the performance of clinical audits in NHS hospitals (project PR7) Supporting the SME supplier to understand and bake-in digital health procedural requirements	• *"We have a really good helicopter view of not just the NHS but also the wider health and care sector, local authorities, academia, the voluntary sector as well. That ability to bring together different voices and different thinking to basically do problem solving, it ensures that the innovators, the people in the businesses are then developing things that are perhaps most relevant to the health and care needs, growth to the population" (Chief Operating Officer, InnoMed).* • *"If you have a person with an initial service or product but they haven't got it in the NHS they may want to see how they can get it in the NHS. You may introduce them to clinicians, you may try to establish what area of the NHS may be interested" (Commercial Manager 3, InnoMed).*

	Supporting suppliers to understand needs and use in context: InnoMed managers spend time and effort to help SME suppliers understand how solutions could fit NHS operating context and meet important needs **Analyzing needs vs. technological options:** InnoMed projects seek to elecit what is technically possible and feasible given NHS requirements and operating constraints	for the children ailment app development (project PR9)	• *"[We] support those innovators and suppliers that want to bring new products through to the NHS and the health and social care system, to navigate that landscape, which can be quite complex at times with procurement and commissioning but also in terms of how they fit in the competitive landscape" (Chief Operating Officer, InnoMed).* • *"From a market access perspective that's what we try and provide, is that way in and be there during the discussions and negotiations as that sort of honest broker, as that critical friend. Again, handholding, not just the SMEs but also the NHS to help them sort of see what the art of the possible might be" (Assistant Commercial Director, InnoMed).*
De-risking novel solutions	**Running experiments and demo projects:** InnoMed seeks to showcase promising technological solutions and to raise awareness of the benefits in both regional and national fora **Organizing trials and field tests:** InnoMed staff invest time in helping to organize clinical trials and 'test beds', linking SME suppliers to suitable NHS actors **Generating evidence – technical, commercial and organizational:** InnoMed assists SME suppliers to generate and assess clincial evidence, as well as analyse the commercial and regulatory factors influencing adoption of the innovative solution	Testing and assessment helps suppliers to de-risk their new technologies for NHS use Evidence generation regarding impact of 3D-printing on time and cost savings in operating theatres (project PR11) Helping SMEs take part in NHS 'test bed' to trial use of portable ultrasound device (project PR12)	• *"The support […] helped [the company] to de-risk its technology and improve its understanding of clinical trials management at a major NHS Trust" (Health Innovation Network Report, 2019)* • *"What people [NHS providers] are doing in the early stages is they're getting… they're going for safety in larger companies rather than smaller companies. There's a higher risk for investing, procuring stuff from a smaller company" (Assistant Commercial Director, InnoMed).* • *"[The company] gone from…if 1 is invention and 10 is sales, he is probably at 3-4 now. But, actually, we can get him to 7 if we get a clinical trial. Most [solutions] are ready to be sold but if you haven't done an evaluation most of the NHS will say 'where's you evidence; who else is using it?' And it stops" (Commercial Manager 1, InnoMed).* • *"They [InnoMed] did a match-funded grant where they stuck some of their money in and then persuaded two hospitals to stick the hospitals' money […] that was really good because there was a [trial] project" (CEO, SME supplier in project PR11).*
Supporting contracting	**Developing industry-informed specifications:** InnoMed leverages industry connections and project knowledge to feed back to the NHS with regard to specification of solution requirements **Consulting on contracting process and contract design:** InnoMed advises SMEs on how to overcome contractual barriers**. It also** works with NHS hospitals on adjustments to procurement processes to enable fast uptake of novel solutions.	Helping the NHS hospitals to consider state-of-the-art technologies and products to inform their requirements Supporting SME suppliers to gain access to NHS framework contracts	• *"What we're trying to do is provide innovation visibility to the NHS by getting into the discussions where the opportunities that the innovators have got, the technology, are visible to the NHS, so they can make informed decisions about when they develop service specifications" (Assistant Commercial Director, InnoMed).* • *"[…] they were small business who had a procurement challenge, they couldn't hit the thresholds of turnover and size to be able to justify them being included on procurement contracts. [InnoMed] worked with a company that provided access to procurement frameworks and helped them [the small business] to get onto the procurement frameworks" (Assistant Commercial Director, InnoMed)*
Facilitating solution implementation	**Analyzing buyer requirements for solution integration:** InnoMed is involved in analysis and evaluation of changes in care pathways to facilitate new technology integration **Educating suppliers to facilitate innovation adoption:** InnoMed emphasis on educating SMEs about how the NHS operates (e.g., governance, regulations and procurement system)	Performing analyses of how novel products and technologies could be integrated into existing care pathways	• *"We deploy joined up complementary technologies at scale to transform how care is delivered and looking at that. Out of that process should then come a different way of commissioning across those pathways" (Chief Operating Officer, InnoMed).* • *"It was good to get the overview of the NHS as an overall market, the diversity of it and complexity of the whole system, and where the funding gets placed and who you need to speak to […] the overview of the task of dealing with the NHS system" (Sales Manager, SME supplier in project PR12).*
Innovation sourcing outcomes	**InnoMed impact on innovations uptake**: 95 new products /services introduced into the NHS in the period 2014-2019. This includes solutions in five projects we studied in detail. **InnoMed impact on cost savings**: £9.5 million from introducing into the NHS technology to improve secondary and primary care operations, for instance reducing hospital length of stay (# bed-days) and re-admission rates. Cost savings were achieved in two projects we examined in detail.	Projects PR7-PR12; More generally, InnoMed aided significantly NHS adoption of novel solutions Projects PR7 and PR8; In general, operational savings achieved but are rather low	• "*We got commissioned to all the children in Cheshire and Merseyside, Women's and Children's Vanguard. So, that's 14 areas, 26 organizations. Big commission […] We're rolling out, I think we're active in seven or nine areas now, growing by the minute and looking to take the next bits" (CEO, SME supplier in project PR9).* • *"Suddenly all of those jobs that people used to have to do, of checking stuff, sending it back, all of that has gone. Actually, you can reduce the number of people that you would need doing that bit of the process. But because those people are trained in audit... I'm not saying get rid of them. I'm saying make better use of their time. Stop them just doing administrative work and let them add value" (Managing Director, SME supplier in project PR7).*

APPENDIX E: Intermediaries' Activities and their Impact on Innovation Sourcing Outcomes: Detailed Analysis Across the Fourteen Projects

Table E.1: Intermediaries help in refining definitions of requirements

Constructs	**InnoDef**						**InnoMed**								**Sum**
	PR1	PR2	PR3	PR4	PR5	PR6	PR7	PR8	PR9	PR10	PR11	PR12	PR13	PR14	**n=14**
Needs articulation															
Articulating future and unmet needs	n/a	✓	✓	✓	✓	✓	✓	✓	✓	n/a	✓	✓	×	×	**10**
Reframing and refining problems	✓	✓	✓	n/a	✓	✓	×	✓	✓	✓	×	✓	×	×	**9**
Needs translation into solution requirements															
Supporting suppliers to understand needs and use	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	**14**
Analyzing needs vs. technological options	✓	✓	✓	✓	✓	✓	n/a	✓	✓	×	✓	×	✓	×	**10**

✓= Yes, project involved this intermediary know-how; ×= no, project did not involve this know-how; n/a=not applicable

Table E.2: Intermediaries assist in de-risking novel solutions

Constructs	**InnoDef**						**InnoMed**								**Sum**
	PR1	PR2	PR3	PR4	PR5	PR6	PR7	PR8	PR9	PR10	PR11	PR12	PR13	PR14	**n=14**
Solution testing															
Running experiments and demo projects	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	✓	×	✓	✓	**12**
Organizing trials and field tests	×	✓	✓	✓	✓	×	✓	✓	✓	✓	✓	✓	×	×	**10**
Solution assessment															
Generating evidence: technical, commercial and organizational	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	**12**

✓= Yes, project involved this intermediary know-how; ×= no, project did not involve this know-how; n/a=not applicable

Table E.3: Intermediaries support contracting

Constructs	**InnoDef**						**InnoMed**								**Sum**
	PR1	PR2	PR3	PR4	PR5	PR6	PR7	PR8	PR9	PR10	PR11	PR12	PR13	PR14	**n=14**
Specification-setting															
Developing industry-informed specifications	✓	✓	✓	✓	✓	✓	✓	✓	n/a	×	n/a	✓	×	×	**9**
Contracting															
Consulting on contracting process and contract design	✓	✓	✓	✓	×	✓	✓	✓	×	✓	n/a	✓	×	×	**9**

✓= Yes, project involved this intermediary know-how; ×= no, project did not involve this know-how; n/a=not applicable

Table E.4: Intermediaries facilitate novel solution implementation

Constructs	**InnoDef**						**InnoMed**								**Sum**
	PR1	PR2	PR3	PR4	PR5	PR6	PR7	PR8	PR9	PR10	PR11	PR12	PR13	PR14	**n=14**
Innovation integration															
Analyzing buyer requirements for solution integration	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	**12**
Innovation adoption facilitation															
Educating suppliers to facilitate adoption	×	✓	✓	✓	✓	n/a	✓	✓	✓	✓	✓	✓	×	×	**10**

✓= Yes, project involved this intermediary know-how; ×= no, project did not involve this know-how; n/a=not applicable

Table E.5: Innovation sourcing outcomes in the intermediaries' projects

Constructs	**InnoDef**						**InnoMed**								**Sum**
	PR1	PR2	PR3	PR4	PR5	PR6	PR7	PR8	PR9	PR10	PR11	PR12	PR13	PR14	**n=14**
Innovation uptake	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×	×	**12**
Cost savings	✓	×	✓	✓	×	n/a	✓	✓	×	n/a	×	×	×	×	**5**

✓= Yes, project achieved outcome; ×= no, project did not achieve outcome; n/a= no available evidence (outcome could not be demonstrated)

APPENDIX F: Cross-Case Analysis – Relationships between the Key Constructs

Table F.1: Qualitative evidence supporting the identified relations between constructs

Relationships between constructs	Underpinning mechanisms at play	Exemplar representative quotes
Interface-building capability helps to translate buyer needs into feasible solution requirements.	Intermediaries' matching of problems with solutions: (1) enhances supplier understanding of buyer needs (2) facilitates interactions between buyers, intermediaries, and suppliers to identify feasible requirements and associated solutions	• *"We try to provide an industry-informed input to the acquisition process. What is the art of the possible? What are the pitfalls to avoid? We've done quite a lot where we've looked at the marketplace and tried to understand the maturity of technologies and products. We've built demonstrators with representative products, and all the time we have to be careful not to compromise —demonstrate competition […] I think that's been really important for both the MoD and industry because industry, by engaging the projects, get a much better understanding of what it is that MoD actually wants and MoD gets a much better understanding of what industry can provide" (Technical Director, InnoDef).* • *"That was the deal in terms of why would they [suppliers] bother coming in. They gain influence, they gain approach, and they make decisions on what they see" (Delivery Director, InnoDef).* • *"From a market access perspective that's what we try and provide, is that way in and be there during the discussions and negotiations as that sort of honest broker, as that critical friend. Again, handholding, not just the SMEs but also the NHS to help them sort of see what the art of the possible might be" (Assistant Commercial Director, InnoMed).* • *If they [senior managers of hospitals] coming to understand "who can…" you've got this big problem, what options do you have to actually resolve that problem of which technology is part of the element but not the sole element? I think you get a much better response, much better (Healthcare Director, SME supplier in project PR8).*
Expertise-spanning capability assists evidence-based assessment and de-risking of solutions.	Intermediaries contribute by: (1) forming inter-organizational teams of experts who test and assess potential solutions (2) involving end-users in field testing and evidence generation activities	• *"One of the unique features of [InnoDef] is that we draw in 'best athletes' from across 175 different organizations in the partnership to construct a project team to work on a project; obviously the skills required determine the kind of people we're looking for […] So we ended up with a collaborative construct with a number of fairly unique features to do three kinds of work: applying best practice to the defense domain, gathering evidence and experimentation" (Technical Director, InnoDef)* • *"[We] run a practical experimentation activity which tested that solution concept, or a number of them, against the metrics we'd kind of developed early on, to work out which solved the problem better. And not just in terms of equipment, you know, this whizzy toy can do this kind of stuff, but more well what's the training burden for the military people, how might they use it, how much kit do you buy, what does its support cost over years, can you support it when you're sitting in the middle of a desert or a jungle somewhere" (Lead of project PR4, InnoDef)* • *"We introduced [3D-printing SME in PR11] to Alder Hey [hospital] and they took a base there and they started working with the orthopaedic surgeons mainly. For children with curved spines, they were able to 3D-print the actual… an absolute replica of the child's spine so for the surgeon operating, you can't turn a child over to see the spine underneath. They had the spine there and could plan the surgery better" (Chief Operating Officer, InnoMed)* • *We went through the [hospital] hackathon, that was [InnoMed] sponsored, that's the project we won the health money for that we're spinning out eventually, fairly soon" (CEO, SME supplier involved in project PR9).*
Work to help refine requirements contributes to the development of	Intermediaries contribute by: (1) helping to articulate buyer problems and needs	• *"InnoDef was tasked to support the Air Command by conducting industry-informed, impartial research into the requirements of Future Air Refuelling System […] As a result of this project and its broad engagement with industry, Headquarters Air Command received an objectively researched, evidence-based view of the requirements for aircraft refuelling capability across the MOD, the options for procuring that capability, and the cost impacts and performance factors associated with them" (MoD case study for project PR6).* • *[…] one of the things [InnoDef] really does is help us understand how the industry sense is on how something would work […] you have much more of a collegiate view on how would you do this (Innovation Lead, DE&S Technology Office).*

informed specifications.	(2) analysing problems and needs vis-à-vis supplier capabilities and technological options	• *"The [HINs], maybe, should be the filter that says "no, that's not innovative, that's not new. Go away". Actually, this new product that actually does things drastically differently and cuts recovery time by half or improves outcomes by 20% is what we should be looking at and we should be getting this in front of the right audience. We should be saying to the NHS Trusts, have you got surgeons which would be interested in piloting this" (Head of Procurement, NHS Hospital).* • *"What we're trying to do is provide innovation visibility to the NHS by getting into the discussions where the opportunities that the innovators have got, the technology, are visible to the NHS, so they can make informed decisions about when they develop service specifications" (Assistant Commercial Director, InnoMed).*
Work to help assess and de-risk novel solutions contributes to solution implementation by analyzing innovation adoption and integration requirements.	Intermediaries' work to test and assess possible solutions and to generate objective evidence: (1) offers insights into buyer requirements for solution integration (2) supports and educates suppliers to pre-empt innovation adoption barriers	• *"Quite often, the MoD had decided to buy something but didn't know how to use it or how to integrate it into everything else so we had some technology, that was great; we sometimes modified it for them or got them to modify to our suggestion, or whatever; but, to fit in with the people, the organisation, etc., to make it work" (Programme Lead responsible for project PR5, InnoDef).* • *"It is important to check that the generated solution is aligned with TEPIDOIL [Training, Equipment, People, Infrastructure, Doctrine, Organization, Information and Logistics] requirements; that is, the solutions considered should be integrated with users' operating requirements" (Managing Director, InnoDef).* • *"Quite often you need an evidence base and evaluation, you need a service integration evaluation to understand the practicalities of how you adopt new technology, and justification as to perhaps when cash will be released, or what the return on investment might be for every pound you spend on that" (Assistant Commercial Director, InnoMed).* • *"We've also been introduced [by InnoMed staff] to a few of these NHS Test Beds as well, so that's been useful in learning off them what sort of things you need to be... you know, the trigger points really of what the benefits of your product's going to be" (Sales Manager, SME supplier in project PR12).*
Support for solution implementation contributes to innovation uptake by buyer.	Intermediaries' work contributes to: (1) explicating innovation integration requirements (2) helping suppliers to adapt to the buyer's processes	• "*The MoD exploited this [InnoDef] output through a change in Joint Helicopter Command policy and more directly for the acquisition of new [helicopter] simulators to conduct Conversion to Role training[...]. These devices will employ motion seats in lieu of full 6 degrees of freedom motion with associated cost savings" (MoD case study for project PR1).* • *"We see our companies [SMEs] on the patch and elsewhere developing stuff that can… based on our knowledge of the system, that can support the system and as well as getting it through traditional commissioning and procurement hurdles, and advising and supporting that" (Assistant Commercial Director, InnoMed)*
Support for contracting helps to generate cost savings for buyer but the intermediaries' capabilities are not sufficient in themselves – cost reduction also hinges on effective and efficient buyer procedures.	(1) intermediaries help buyers to develop more informed specifications and design contracts conducive to supplier innovation (2) effect of intermediaries' contracting support on cost savings is contingent on the buyer's procedures in relation to specification testing, costing, and ordering.	• *"We were recommending in that case [project PR2] a sort of service delivery contract which was incentivised to deliver the service, a separate contract to provide an innovation function that was embedded effectively within the capability in order to, if you like, separate the day-to-day operations from the innovation function […] So, yes, that went all the way through from an idea to an implemented system that MoD acquired through its normal acquisition processes but structured in a way that was a little bit unusual" (Technical Director, InnoDef).* • *"[…] we will work with the procurement team to sort of say that okay, this company only has one product and you're putting out your invitation to tender, or your pre-qualification question there you're saying you've got to have two products and we will work with them to say well that's grossly unfair, you're penalising SMEs (Commercial Manager 2, InnoMed).* • *"They [requirements] also increase costs [of solution implementation] since each requirement must be tested and compliance proved."* (*Project Lead in project PR5, InnoDef).* • *"The first thing we say is when we buy through catalogue, our cost to serve an order is minimised. We have thousands of orders per week for product going through that route. We have centralised invoicing, paid. The minute you go with a different route to order a product our cost to serve is inflated significantly as much as by 100 times because we have an individual purchase" (Procurement Director, NHS Trust).* • *"One of the issues is training staff to be able to do the scans […] that was one of the big obstacles when we researched the market, GPs are for doing it but then it's more… right, well who pays for it and who trains us" (Sales Manager, SME supplier in project PR12).*

Table F.2: How intermediaries' inteface-building capabilities help to refine definitions of buyer requirements

	Helping suppliers understand needs and use context (n=14)	**Analyzing needs vs. technological solutions (n=10)**
Interface-building		
Matching problems with solutions **[Sum=12]**	12	9

Table F.3: How intermediaries' expertise-spanning capabilities help to assess and de-risk novel solutions

	Running experiments and demos (n=12)	**Organizing trials and field tests (n=10)**	**Generating evidence (n=12)**
Expertise-spanning			
Forming cross-organizational teams of experts **[Sum=12]**	10	10	11
Involving end-users **[Sum=12]**	10	10	12

Table F.4: Analysis of the relationship between intermediaries' work to help refine buyer requirements and the development of industry-informed contractual specifications

	Developing industry-informed specifications (n=9)
Articulating unmet and future needs **[Sum=10]**	8
Refining or reframing problems **[Sum=9]**	7 (PR4=n/a regarding refining problems)
Supporting suppliers understand needs and use **[Sum=14]**	9
Analyzing needs vs. technological solutions **[Sum=10]**	7 (PR7=n/a regarding analyzing needs)

Table F.5: How intermediaries' testing and assessment capabilities help to facilitate solution implementation

	Analyzing buyer requirements for solution integration (n=12)	**Educating suppliers to facilitate adoption (n=10)**
Solution testing		
Running experiments and demo projects **[Sum=12]**	10	8
Organizing trials and field tests of solutions **[Sum=10]**	10	10
Solution options assessment		
Generating evidence: technical, commercial, organizational **[Sum=12]**	12	10

Table F.6*: *Intermediaries' impact on innovation sourcing outcomes

Construct (aggregate dimension)	**Sub-constructs (second-order codes)**	**Project evidence (n=14)**	**Evidence regarding innovation sourcing outcomes beyond the 14 projects (based on secondary data)**
Innovation sourcing outcomes	Innovation uptake by buyer	12	• InnoDef impact:131 projects led to uptake of innovations and early integration of technological solutions into military operations in the period 2013-2018 • InnoMed impact: 95 new products /services introduced into the NHS in the period 2014-2019
	Cost savings for buyer	5	• InnoDef impact: £1.89 billion of estimated cost avoidance (self-reported) vs. £140 million MoD initial investment • InnoMed impact: £9.5 million from using technology to improve secondary and primary care operations, for instance reducing hospital length of stay (# bed-days)

Table F.7: Impact of intermediaries' capabilites to facilitate solution implementation on innovation uptake by the buyer

	Number of projects which led to innovation uptake (n=12)	**Number of projects which did not lead to innovation uptake (n=2)**
Innovation integration		
Analyzing buyer requirements for solution integration **[Sum=12]**	12	0
Innovation adoption facilitation		
Educating suppliers to facilitate adoption **[Sum=10]**	10	0 (PR6 = n/a)

Table F.8: Impact of intermediaries' capabilities to support contracting on cost savings for the buyer

	Number of projects which achieved cost savings (n=5)	**Number of projects which did not achieve cost savings* (n=7)**
Specification-setting		
Developing industry-informed specifications **[Sum=9]**	5	3 (PR9 =n/a)
Contracting		
Consulting on contracting process and contract design **[Sum=9]**	5	2

* No available evidence to verify the outcome (cost savings) in projects PR6 and PR10.

Highlights

- Government-founded intermediaries support collaborative innovation in supply chains and drive uptake of novel solutions by tackling shortfalls in the capabilities that buyers and suppliers require to access each other's knowledge for innovation purposes.

- The requisite capabilities can be specific to technologies or sectors little known to buying or supplying firms – using an intermediary to access context-specific capabilities is an efficient way to source innovations in sectors characterised by fast technological and market change.

- Buyers and suppliers must develop certain sets of capabilities to access intermediaries' capabilities – these include abilities to manage intermediary performance by defining innovation objectives and resource investments, and to exploit the outputs of intermediary-initiated innovation projects.