Impeding Factors for the Generation of Collaborative Innovation Performance in Ecosystem-based Manufacturing

ABSTRACT

Purpose

Although there is a growing body of literature on the benefits of innovation ecosystem participation for keystone/ focal firms, there are limited studies on what motivates or impedes other actors' participation (i.e., suppliers, and complementors) in collaborative innovation. Hence, this study aims to address the root causes of collaborative innovation failure and develop a better understanding of the hindering factors for the generation of collaborative innovation performance in ecosystem-based manufacturing.

Methodology

We undertook a qualitative research study with 45 managers involving an online survey with open-ended questions followed by an expert focus group with seven managers from a UK-based high value manufacturing ecosystem. Data analysis and coding followed a highly iterative process using a thematic analysis approach.

Findings

This study identified six common barriers to collaborative innovation from the perspective of supplier firms. Particularly, we found unique impeding factors in relation to revealed and deterring barriers in an ecosystem-based manufacturing context. We argue that suppliers and small and medium-sized enterprises (SMEs) not only require financial support but also need to develop a strategic mindset, confidence, effective partnerships, and knowledge about risks and returns to participate in collaborative innovation.

Originality

The extant literature identifies the motivations for joining innovation ecosystems and the prominence of value co-creation activity from the perspective of focal firms or orchestrators. However, this study offers insights into the need for an effective *value co-appropriation* setup among the ecosystem actors including suppliers. Importantly, we propose that effective value co-appropriation is essential for making collaborative innovation happen.

Keywords manufacturing; innovation ecosystem; value co-creation; value co-appropriation; suppliers; barriers

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1. Introduction

It takes a village to raise a child. Indeed, collaboration with others in the ecosystem plays a critical role in an organisation's ability to innovate and perform in the long term. Consequently, innovation is considered as a distributed activity increasingly taking place across a constellation of actors (Chesbrough, 2017; Bessant and Möslein, 2011). Moreover, the grand challenges of today are increasingly being tackled by new forms of collaborative and multi-organisational arrangements, representing the ecosystems. Consequently, the opportunities for individuals, organisations and countries to cooperate are even larger today—from tackling Covid-19 to moving to a net zero economy (Brandenburger and Nalebuff, 2021). For example, ecosystems explain the rapid progress in monitoring the spread of Coronavirus (e.g., the track and trace apps for Covid-19). Apple and Google's decision to cooperate in creating innovative contact-tracing technology for Covid-19 enabled a rapid response to the pandemic. By sharing user location data across platforms, the two companies cooperated with governments, health organisations (e.g., NHS in the UK), other suppliers, and users to create effective notification apps. Therefore, a better understanding of innovation ecosystems (Adner, 2006) will help today's businesses, managers, and nations find a better way to innovate, perform and succeed together (Beaudry et al., 2021; Brandenburger and Nalebuff, 2021).

According to Olsson and Bosch (2016: 206), "collaborative innovation refers to joint efforts involving a number of stakeholders and is driven by the willingness to openly share and benefit from results within the network". There are more than 80,000 ecosystem stories published per annum in various forms of media (Kapoor, 2018). Despite the increasing recognition of innovation ecosystem research, there are limited studies investigating what hampers or accelerates collaborative innovation at the ecosystem level. According to Almpanopoulu et al. (2019: 6357), "a comprehensive understanding of barriers and constraining mechanisms is largely absent in the innovation ecosystem literature". Moreover, there are calls for future studies to clarify typologies and managerial perceptions and differentiate innovation barriers and barriers for open and collaborative innovation to develop a clear understanding of the generation of collaborative innovation performance (Bag et al., 2022; Dubouloz et al., 2021; Dziurski and Sopi ska, 2020).

In this paper, we address the challenge of developing a better understanding of the managerial perceptions regarding barriers to collaborative innovation generation at the ecosystem level. We do so by acknowledging innovation as a multilevel phenomenon (Klein and Sorra, 1996) and the coherent call for multilevel approaches (e.g., Crossan and Apaydin, 2010). We go beyond the mere investigation of firm-level innovation barriers; instead, we investigate the collaborative innovation phenomenon at the ecosystem level. The proposed classification of barriers for the generation of collaborative innovation performance is presented in a framework. Further, we provide guidelines on how managers and policymakers can overcome those barriers.

Among the ecosystem actors, most attention has focused on lead-focal-keystone firms with limited attention given to understanding the collaborative innovation activities of suppliers and complementors (Bogers et al., 2019; Teece, 2016; Adner and Kapoor, 2010; Iansiti and Levien, 2004). Based on the gaps in the literature, this paper is focused on a supplier perspective in a high-value manufacturing ecosystem in the UK. This approach is in line with extant literature; for example, a study by Hueske and Guenther (2015) highlighted the need for future studies which are more context-specific to better understand what hampers collaborative innovation efforts. The authors called for more research that includes multiple levels of analysis, and context specificity.

Investigating the UK context is interesting and timely as the UK government's Industrial Strategy has placed collaborative innovation at the crux of economic growth and sustainability (Innovate UK, 2018, 2019). The year-on-year increase in publicly funded collaborative innovation programmes reflects this ambition (Scandura, 2016). To achieve this delivery plan, public sector organisations are starting to embrace the notion of innovation ecosystems to enable collaboration with private sector partners and reduce the barriers to collaborative innovation generation (Micheli *et al.*, 2012; Innovate UK, 2018, 2019).

Like the global financial crisis in 2008, the most recent Covid-19 pandemic has highlighted the need to have a more resilient local manufacturing capability due to international supply chain disturbances (Huq *et al.*, 2021). The competitive threat of cheaper substitute products from China led the UK government to develop a high-value manufacturing strategy (Huq *et al.*,

2021). Based on this strategy, the UK Government has started several strategic initiatives while recognising the importance of collaborative innovation in manufacturing, e.g., Made in Britain, Innovate UK, National Manufacturing Institute Scotland (NMIS), Knowledge Transfer Partnership (KTP), ReshoringUK, and High Value Manufacturing (HVM) Catapult. These initiatives aim to address the productivity puzzle while increasing collaborative innovation in the manufacturing ecosystem (Paton *et al.*, 2021; Caballero, 2014; MacBryde *et al.*, 2013; Raymond and St-Pierre, 2010; Lawson and Samson, 2001). Extant literature has highlighted the salience of leaders and managers as being important determinants for the adoption of innovation (Bag et al., 2022; Mohammed, 2019). Hence, this study has focused on individual agency by analysing how managers interpret their firm's innovation activities and participation in manufacturing ecosystems. Accordingly, this study aims to address the following research question: *How do manufacturing suppliers perceive barriers to participating in innovation ecosystems?*

The remainder of this paper is organised as follows. The next section reviews and synthesises the extant literature while focusing on clarifying the underlying barriers to participation in innovation ecosystems. This paper proceeds with conducting empirical research by collecting data from a sample of 45 managers in the UK through a survey with open ended questions. In order to gather multiple sources of evidence, we have also conducted an expert focus group study. The unit of analysis comprises individual managers in order to understand the voice of the manufacturing suppliers. Finally, we conclude with observations pertaining to future research directions, limitations, and managerial insights for decision-makers in industry and policy environments.

2. Literature Review

According to Crossan and Apaydin (2010), innovation is change, renewal and enlargement of products, services, and markets; development of new methods of production; and establishment of new management systems. Carayannis and Campbell (2009) add that innovation is a highly sophisticated, non-linear, and dynamic process of knowledge creation, transmission and utility and there is a need to reconceptualise and reinvent how we do innovation. Indeed, innovation is increasingly recognised as needing open and collaborative approaches (Dubouloz et al., 2021; Chesbrough, 2017) that take place in innovation

ecosystems (Ghazinoory et al., 2020; Almpanopoulou et al., 2019; Adner, 2017). Consequently, firms are progressively engaging with collaborative innovation to leverage external resources and partnerships to improve performance and accomplish the innovation objectives that they otherwise could not afford to do on their own.

Since policy makers aim to create a convergent space to make collaborative innovation happen, they see eliminating barriers (Loewe and Dominiquini, 2006) to collaborative innovation generation as a key objective. Therefore, the UK government has set up collaborative innovation centres such as the High Value Manufacturing (HVM) Catapults across the country. This study context is high value manufacturing and aims to understand factors that may hinder participation to such manufacturing innovation ecosystems. Therefore, the following literature review focusses on explaining innovation ecosystems and then the impeding factors for collaborative innovation in an ecosystem-based manufacturing context (Bag et al., 2022).

2.1. Innovation Ecosystems

The term 'ecosystem' was first applied in the academic literature in the mid-1990s by James Moore who was trying to understand how firms could continue performing and attain sustainable advantage by out-innovating rivals (Moore, 1993). Due to its relevance to explain today's complex and volatile business environment, interest in the ecosystem notion has increasingly gained attraction in academia, policy and practice (Beaudry et al., 2021).

Innovation ecosystems are focused on value creators (Millard, 2018). They explain the distributed, collaborative, and networked innovation activities among actors including suppliers and SMEs (Dubouloz et al., 2021; Mohammed, 2019; Adner, 2017). Firms decide on how to find partners in collaborative networks and ecosystems for different motivations such as technological evolution, diversification opportunities, value chain, and business environment that generate ambiguity and pressure on individual firms (Durugbo, 2016).

Importantly, ecosystems feature evolution, collaborative arrangements, value networks, open and distributed innovation, and inter-organisational relations (Bessant and Moslein, 2011; Adner, 2006). An innovation ecosystem encompasses various actors, stakeholders, and

members that are important for collaborative innovation to happen (Figure 1). An actor is a legally independent, but economically interdependent unit involved in performing separate productive activities within the ecosystem (Jacobides et al., 2018). These actors include, for instance, customers/OEMs, suppliers, policy makers, universities, government, firms, unions, private investors, foundations, the media, and the regulatory bodies (Millard, 2018; Autio and Thomas, 2014; Jackson, 2011). Moreover, Song (2016) distinguishes the roles of actors in the ecosystem into three groups, that of focal firm, upstream component actors and downstream complementary actors. Song (2016) and Skippari *et al.* (2017) suggest that the divergent roles of each actor lead to differing levels of value co-creation and cooperative innovation performance. However, most attention has focused on lead-focal-keystone firms with limited attention given to understand the activities of suppliers and complementors that can be members of multiple ecosystems (Bogers et al., 2019; Teece, 2016; Adner and Kapoor, 2010; Iansiti and Levien, 2004).

<Insert Figure 1 here>

Consequently, ecosystems can accommodate a constellation of organisations (see Figure 1) with a valuable offering which, in turn, enables the co-creation of a more extensive value proposition (Dedehayir et al., 2018; Adner and Kapoor, 2010). The foundation for ecosystem research is the presence of complementarities and interdependence between actors beyond supply chains, which forms sophisticated relationships within the ecosystem.

For example, Van Gils and Rutjes (2017) studied the chemical sector in the Netherlands to understand the relationship between small firms and innovation ecosystems. They developed the notion of innovation biotopes, which is a specific cross-section of an innovation ecosystem. They concluded that biotopes are the most pertinent collaborative innovation interface for these firms, which allows for open innovation in a closed ecosystem enabling the acceleration of the innovation process. The stakeholders in a biotope are cautiously selected based on their ability to offer contributions. Sydow *et al.* (2015) also supported this view in their innovation concerning the closed networks argument. Similarly, we could view many catapult centres in the UK as examples of collaborative innovation in a closed ecosystem due to their setup and membership-based business model (High Value Manufacturing Catapult, 2021).

Consequently, the innovation ecosystem literature is a young and growing area of research that has close links with literature on supply chain networks, clusters and inter-organisational relations (Herrera and Trujillo-Díaz, 2021; Jacobides et al., 2018). It seeks to clarify value co-creation and value capture through the collaborative innovation process (Khademi, 2020; Gomes et al., 2018). Although there have been efforts to understand various aspects of innovation ecosystems, more research is needed to identify enablers and barriers of value co-creation and capture the mechanisms of such ecosystems (Almpanopoulou et al., 2019).

2.2. Factors Impeding Collaborative Innovation Generation

Prior research has identified several factors to explain why certain firms innovate more than others and what the determinants of innovation are (De Jong and Marsili, 2006; De Jong and Vermeulen, 2006). Ensuring the right skills and expertise, a convergent and collaborative space for innovation to happen, a market sizable and flexible enough to attract investment and the timing and acceptance of new technologies, are necessary for increased innovation activity at the ecosystem level (Adner and Kapoor, 2016; Smith, 2015; Caballero, 2014). However, putting together all these elements and key stakeholders in the right ways at the right time is a difficult task (Hoffman *et al.*, 1998).

Not surprisingly, the innovation path is complex and perpetually punctuated by obstacles, failures, risks and barriers (Castillo-Vergara et al., 2021; Bogers et al., 2018; Birkinshaw *et al.*, 2007; Loewe and Dominiquini, 2006). Although previous research has indicated that greater supplier involvement benefits innovation performance (Herrera and Trujillo-Díaz, 2021; Afuah, 2000; Skippari *et al.*, 2017) the lack of own funds and the high perceived costs are among the most cited factors hampering innovation (Bag et al., 2022; Moon-Koo et al., 2018; OECD, 2014). For example, Wagner *et al.* (2011) identify several restraining forces to innovation, e.g., lack of strategy, legacy issues, lack of time, knowledge, employee empowerment, past experiences and existing company procedures. Another example is that Huang and Chi (2013), in their empirical study of Chinese high-tech firms, conceptualised innovation barriers into two clusters: kinetic and static.

Similarly, the 2005 UK Innovation Survey investigated more than 28,000 UK-based manufacturing and service firms with a minimum of 10 employees (D'Este *et al.*, 2012). This study identified four groups of barriers to innovation: 1) Cost Factors (excessive perceived economic risks, direct innovation costs being too high, cost of finance, availability of finance); 2) Knowledge Factors (lack of qualified personnel, lack of information on technology and markets); 3) Market Factors (market being dominated by established firms, uncertain demand for innovative goods and services); and, 4) Regulation Factors (need to meet the UK Government and EU regulations).

Based on our in-depth analysis of the literature (See Table 1), we acknowledge the mature state of literature on traditional barriers to innovation at the firm level (Bag et al., 2022; Das et al., 2018; D'Este *et al.*, 2012, 2014; Wagner *et al.*, 2011; Loewe and Dominiquini, 2006). However, there are gaps in the literature; first, in relation to the behavioural underpinnings of those barriers (Skippari *et al.*, 2017; Huang and Chi, 2013; Roy and Sivakumar, 2010); and, second, the role of managerial perceptions in the generation of collaborative innovation performance at the ecosystem level is less understood (Dubouloz et al., 2021; Ghazinoory et al., 2020; Adner, 2006). Hence, there is a need for deeper understanding of perceived barriers to participating in innovation ecosystems in different contexts to inform policy makers and practitioners (Gomes *et al.*, 2018; Skippari *et al.*, 2017; Hueske and Guenther, 2015; D'Este *et al.*, 2012, 2014).

<Insert Table I here>

As presented in Table 1, D'Este *et al.* (2012) bring further granularity to the phenomenon and argue that managers may perceive a particular factor (e.g., high cost) either as a deterring or revealed barrier to innovation depending on their innovation engagement levels. *Revealed barriers* denote the firm's awareness of the difficulties involved because of direct experience, past or present engagement in innovation activities. *Deterring barriers* refer to difficulties pertaining to innovation, perceived as being questionable regarding risk and return with no direct experience or engagement in innovation. Due to the nature of deterring barriers, those might discourage some firms from any future engagement in the innovation ecosystem, which is not a desirable outcome for the economy. Although this classification is useful, the extant literature has identified those deterring and revealed barriers to innovation at firm level only

(e.g., D'Este *et al.*, 2012). As a result, we have limited understanding of the deterring and revealed barriers to collaborative innovation at the ecosystem level.

Lastly, studies focusing on a manufacturing supplier perspective are limited, e.g., Skippari *et al.* (2017) identify that social exchange processes drive collaborative innovation activities from a supply chain perspective. They highlighted managerial perceptions can occur on three levels: '1) how focal firm perceives its own role, 2) how focal firm perceives the other supply chain member's role, and 3) how other firms perceive the focal firm's role in generating opportunities for collaborative innovations' (Skippari *et al.*, 2017, p. 115). Understanding the manufacturing suppliers' perceptions concerning the barriers to collaborative innovation is important because suppliers can be members of multiple ecosystems for new value creation (Adner and Kapoor, 2010) (See Figure 1). Since innovation activity increasingly materialises through partnerships within ecosystems rather than within individual firms, this paper will focus on understanding the managerial perceptions regarding the revealed and deterring barriers to participating innovation ecosystems in the context of manufacturing suppliers.

3. Methods

We accessed data through a manufacturing innovation centre in the UK, the HVM Catapult, while adopting a purposive sampling method (Patton, 2005). HVM Catapults are aiming to create an innovation ecosystem by bringing together various actors (High Value Manufacturing Catapult, 2021), e.g., entrepreneurs, SMEs, OEMs, support agencies, consultancy firms, local governments, independent research institutes, and universities. Aligned with the government policy, the Catapults are also tasked with engaging SMEs and local suppliers to increase their innovation activity in the manufacturing ecosystem (High Value Manufacturing Catapult, 2021). However, there are several barriers to collaborative innovation and there is a need to research this newly emerging phenomenon of ecosystem-based manufacturing (Rong et al., 2020; Skippari et al., 2017).

To address this challenge, this study is focused on the metals-related enabling industries as a subset within ecosystem-based manufacturing. Particular features of this subset are interesting and timely to research because metals suppliers are key enablers to various high value innovation ecosystems in manufacturing (e.g., medical devices, automotive, rail, marine,

aerospace, renewables, construction, oil and gas). However, in recent years, the UK metals sector has been facing major challenges due to global competition and increased costs, e.g., UK steel industry challenges (Hutton, 2021). The threat (or opportunity) of disruptive technologies such as additive manufacturing and metal 3D printing (mostly powder based) are increasingly used in metals-related industries such as medical devices (e.g., orthopaedic implant manufacturing) and aerospace. Therefore, metals industry firms, and particularly SMEs, increasingly need to work with other partners, engage in collaborative innovation to improve performance, and stay viable.

We undertook a qualitative research approach involving an online survey with open-ended questions followed by an expert focus group. Our study builds on previous studies investigating the innovation process in a manufacturing context such as Made in Europe (Voss *et al.*, 1998), Global Manufacturing Research Group (GMRG) (Whybark, 1997), International Manufacturing Strategy Survey (IMSS) (Netland and Frick, 2017) and High Value Manufacturing (HVM) (Livesey, 2006). Therefore, the literature review findings and these major manufacturing programmes influenced our research design. Each ecosystem actor has a specific degree of innovation orientation that entails firm-wide shared beliefs and perceptions driving an actor's motivation to innovate (Skippari *et al.*, 2017; Simpson *et al.*, 2006). Hence, the generation of collaborative innovation can be influenced by the firms' activities based on managerial perceptions. As our aim is to understand those managerial perceptions regarding what impedes participation in innovation ecosystems, the unit of analysis is the individual managers (i.e., individual agency) (Denzin and Lincoln, 2000).

3.1. Data Collection

Our primary data collection and analysis consisted of two stages (Figure 2). The initial phase involved conducting a qualitative survey using Qualtrics software with open-ended questions in order to gain deeper insights from the managers. We favoured this method over conducting face-to-face interviews in order to access as many managers as possible for validity and reliability purposes (Miles *et al.*, 2013; Easterby-Smith *et al.*, 2012; Maxwell, 2012). The online survey instrument included open-ended questions allowing free text entry (See Appendix I). We used a purposive sampling method (Patton, 2005) and accessed potential respondents through a database of contacts derived from two different HVM Catapults.

<Insert Figure 2 here>

All the companies in the sample were operating within metals-related manufacturing supply chains in the UK. In total, we sent 97 invitations, from a large database of contacts representing UK metals manufacturing ecosystem actors. The respondents were holding managerial positions and this sample represented the total population available. Short telephone interviews followed up some questions retrospectively and enticed more managers to respond and complete the survey. We received 45 usable responses, which was satisfactory given the seniority of the respondents and the confidentiality of the questionnaire, which included strategic innovation activities. Among the respondents, 21 managers worked in SMEs and 24 managers worked for larger firms with more than 250 employees. The breakdown of the sample in terms of the sector of operation is: metals forging and forming, machining, casting of aerospace and medical components, manufacture of metal components, design and assembly, steel manufacturing, oil and gas flow line and valve equipment manufacturing, oil and gas wellhead and allied equipment supply, aircraft repair and overhaul, metal decorating, suppliers of titanium components, design and manufacture of wind turbine products, and manufacture of metal closures for the spirits industry.

To add further robustness to data collection and to counteract the limitation of the sample, we organised a daylong expert focus group with seven senior managers responsible for collaborative innovation programmes from four UK-based metals suppliers (see Figure 2). The rationale for pursuing an expert workshop was to triangulate data and to increase the external validity of the analysis and findings. The selection of those four suppliers relied on convenience sampling (Miles *et al.*, 2013) as these managers showed greater interest in participating in the second phase of the research study. We designed the workshop in a way to complement and validate the survey findings; therefore, aiming to reflect on and validate the revealed and deterring barriers to collaborative innovation. We captured workshop outcomes using MindGenius mapping software, flipcharts and post-it notes and, then, prepared a written report. We shared this report with the workshop participants for peer-review to ensure external validity.

We used qualitative thematic analysis (Braun and Clarke, 2006). We exported the qualitative data collected from the open-ended questions and the workshop to an MS Excel database for analysis. Data analysis and coding followed a highly iterative process. Then, we organised six online conference calls with the wider research team to review coding results and to discuss the findings for internal validity purposes (see Figure 2). To add further robustness to the coding, we wrote up the meeting minutes and shared them with the project team members to increase the traceability and reliability of the analysis process.

4. Findings

Central to our examination is the concept of *revealed barriers* which, in the context of innovation ecosystems, refers to the firm's awareness of the challenges involved because of direct experience in collaborative innovation projects. On the other hand, *deterring barriers* refers to difficulties concerning collaborative innovation based on preconceived ideas rather than having direct experience in participating in innovation ecosystems. We observed a number of revealed and deterring barriers and categorised the two groups of firms as follows. We asked managers whether they had been directly engaged in collaborative innovation activity in the past. We also asked whether they have an innovation strategy and invested in any innovation facilities (Appendix I). Based on this approach, one group included firms facing revealed barriers (19 firms) and the second group included firms facing deterring barriers, that is, the sample having neither an innovation strategy nor direct involvement in collaborative innovation projects or investment into innovation (26 firms).

In addition, the focus group study revealed that metals suppliers, particularly SMEs, are struggling to get their 'foot in the door'. They are lacking knowledge about customer/OEM/ecosystem leader needs and do not have mature business processes and procedures. These weaknesses have led them to gain a perceived lack of capacity, capability and record of accomplishment coupled with a limited or no participation in innovation ecosystems. As a result, these barriers put metals manufacturing firms and SMEs under pressure on how to balance the value and risks involved in collaborative innovation projects. Table II presents the thematic analysis of data.

<Insert Table II here>

The firms with or without past experience in collaborative innovation exhibited six common barriers, i.e., high costs, payback issues, lack of resources, lack of understanding of customer needs, lack of qualified people, skills and knowledge, and lack of effective partnerships to make collaborative innovation happen (Table II). Firms, which had an innovation strategy and/or invested in an innovation facility not only reported those six common barriers but, also, displayed a certain type of revealed barrier, i.e., production pressures and capacity problems. On the other hand, supplier firms with no direct experience in collaborative innovation reported a deterring barrier, i.e., lack of forward thinking by top management. Our findings are presented in Figure 3.

<Insert Figure 3 here>

5. Discussions

Carayannis and Campbell (2009) highlight that there is a need to reconceptualise and reinvent how we do innovation to improve performance. Accordingly, interest in the innovation ecosystem notion is on the rise in policy and academic environments (Adner and Kapoor, 2010). Based on this need, this study aimed to engage with an important part of the productivity puzzle by increasing collaborative innovation in manufacturing ecosystems. Our starting point clarified the barriers to collaborative innovation generation as collaborations inherently involve innovation ecosystems. If government initiatives such as HVM Catapults aim to entice SMEs and local suppliers to participate in innovation ecosystems to improve performance, then we first need to understand the managerial perceptions regarding what hampers collaborative innovation generation. To answer our research question, we focused on analysing the collaborative innovation phenomenon by investigating multiple actors in a high value manufacturing ecosystem.

We developed a framework (Figure 3) and argue that, particularly within those actors that have no direct experience with collaborative innovation, there is a stronger focus on short-term incremental activities rather than forward-looking step-change innovation (Reid *et al.*, 2015). For example, a manager of an aerospace industry supplier recalled, '*we are good at firefighting*.' In several of the firms, innovation activity was not addressed strategically and, therefore, we identified *lack of forward thinking* as a major deterring barrier. We also found

that this barrier was highlighted much less in firms, which were already engaged in collaborative innovation. Instead, operational problems such as *production pressures and capacity constraints* were important revealed barriers in those firms. Part of the collaborative innovation challenge was time constraints on the teams because they had to focus on the day job instead. One of the focus group participants highlighted this point as follows '*operations always win the battle.'*

Accordingly, we propose that prioritising and balancing strategic and operational focus, as well as risk and value, becomes important to entice more suppliers and SMEs to participate in innovation ecosystems. While most managers had a perception that innovation programmes involve high costs, the justification for the business benefits (i.e., payback) was underlined to be highly challenging. Thus, we argue that a low tolerance for failure, with little headroom for speculative activity needed for collaborative innovation, is ubiquitous, particularly among SMEs. Therefore, the value and risks associated with participation in innovation ecosystems become key themes in addressing the productivity challenge. In particular, manufacturing supplier firms and SMEs need more targeted support for establishing a strategic mindset, understanding the benefits of collaborative innovation, balancing operational pressures and de-risking innovation through collaborative activity.

This is an important contribution because the innovation ecosystems literature is mainly focused on new value creation (Khademi, 2020; Millard, 2018; Adner and Kapoor, 2010) and identifying the benefits involved for ecosystem leaders/ keystone companies (Teece, 2016; Iansiti and Luvien, 2004). Our findings show that suppliers and SMEs also need to see clear benefits for themselves before participating in innovation ecosystems. To build on existing knowledge, we propose that an effective value co-appropriation setup among the ecosystem actors is important for successful collaborative innovation. Effective and fair value co-appropriation means balancing risks and benefits for all actors including SMEs and suppliers in innovation ecosystems. That is the reason why the value appropriation dynamic (Paton et al., 2021; Adner, 2017; Clarysse *et al.*, 2014) deals with who gets what from the ecosystem. This is a key dynamic that determines a firm's performance and competitiveness in the ecosystem.

5.1. Contributions to Theory

Our contribution to the theory is two-fold. First, we consider innovation as a multilevel phenomenon (Klein and Sorra 1996). Therefore, we build on previous work concerning the categorisation of deterring and revealed barriers to innovation (D'este et al., 2012). To add granularity to this categorisation, which was developed at the firm level, we conducted a bottom-up analysis consisting of a high value manufacturing ecosystem in the UK. Surprisingly, our analysis revealed that additional money spent on collaborative innovation may not offer real performance benefits to suppliers and may even disrupt current operations and customer orders. They fear that participation to innovation ecosystems may take their focus away from the day-to-day running of the company. This means that perceived lack of value and risk mitigation strategies in relation to collaborative innovation may create deterring and revealed barriers among those ecosystem actors (Skippari *et al.*, 2017; Harmancioglu *et al.*, 2009; Andrew *et al.*, 2006).

Second, Adner (2006) defines innovation ecosystems as the collaborative arrangements through which firms incorporate their independent offerings into a coherent and customer-focused solution. We add to the current body of knowledge by highlighting the increasing salience of joint value appropriation besides the commonly researched theme of value co-creation (Khademi, 2020; Millard, 2018; Adner and Kapoor, 2010) in innovation ecosystems. In doing so, we contribute to innovation ecosystems theory (Jacobides et al., 2018; Adner, 2006) by introducing a new concept – *value co-appropriation* which means ensuring the necessary mechanisms are in place to enable all actors participating in collaborative activity in an ecosystem receive a fair share of the created new value.

This is important as the actors in an ecosystem become more dependent on each other as innovating without effective value co-appropriation leads to failure (Paton et al., 2021; Jacobides *et al.*, 2018). This study verifies that knowledge, financial and demand constraints are inherent in the existing literature (Pellegrino and Savona, 2017; Amara *et al.*, 2016; D'Este *et al.*, 2012, 2014; Wagner *et al.*, 2011; Madrid-Guijarro *et al.*, 2009; De Jong and Marsili, 2006). However, we argue that manufacturing suppliers and SMEs not only require financial support, they also need to develop a strategic mindset, confidence, effective partnerships,

and knowledge about risks and returns to participate in innovation ecosystems (Herrera and Trujillo-Díaz, 2021; Pellegrino and Savona, 2017; Amara *et al.*, 2016).

5.2. Implications for Policy and Practice

Our study has some key policy implications that can be transferred to other similar contexts (Gioia, 2021; Lincoln and Guba, 1985). First, the risk of not meeting customer demand and, thus, of failing to appropriately value, may avert manufacturing suppliers and SMEs from engaging with innovation ecosystems. As a result, this could have detrimental effects upon their long-term viability and performance. We propose that perceived high levels of innovation value through fair value co-appropriation arrangements have potential to focus managerial attention on innovation ecosystem participation. Despite the presence of various common and distinctive barriers to collaborative innovation, several managers in our sample openly shared with us their call out for support, as reflected in the following quote (among others): *"The sector needs help that comes faster and easier and we need some way of accessing all information with low cost outlays"*.

Second, the extant literature fails to distinguish the different nature of the barriers to collaborative innovation generation at the ecosystem level (Skippari *et al.*, 2017; Amara *et al.*, 2016; D'Este *et al.*, 2012, 2014). This distinction is important for policy because it has the potential to help create more targeted innovation support programs (Hölzl and Janger, 2013, 2014) while addressing the root cause of the problems. Our study shows that much of the current innovation activity is likely to fall into incremental development and operational problem solving. This is coupled with high production pressures, productivity issues and is likely to contribute to underlying views of collaborative innovation not fitting the company perception of its own internal activity. This can potentially lead to the apparent disconnect between the innovation ecosystem and the supplier-working environment. To overcome these barriers, policy makers should offer more simplified communications for collaborative innovation support in terms of de-risking innovation, protection of IP, clarifying benefits for all actors and providing skills and expertise.

Third, de-risking innovation is a major area of concern for manufacturing suppliers including SMEs. Therefore, a more balanced approach to opportunity and risk, together with a

coordinated and connected innovation community could result in improved innovation ecosystem performance in the UK. De-risking innovation can be achieved through establishing effective value co-creation and co-appropriation mechanisms, getting support in IP protection, pooling resources and developing a more ecosystem-based approach to innovation (Shaw and Burgess, 2013; Pittaway *et al.*, 2004).

Overall, our findings could be transferrable to similar innovation ecosystems delivering complex product-service bundles. Innovation activities are mainly demand/market led and there is a lack of collaboration culture with external partners in the innovation ecosystem (Shaw and Burgess, 2013; Wagner *et al.*, 2011). Thus, managers should work towards building long-term partnerships with other ecosystem actors in order to have better access to customer needs. In doing so, they will have a clearer view of the potential customers/OEMs and their needs and problems to identify how they can best innovate together. Practitioners can also learn from other sectors both in the UK and abroad by linking with other ecosystem actors.

5.3. Limitations and Future Research

As with all research, the current study is not without its limitations. First, this study offers suggestions to encourage manufacturing suppliers to develop collaborative innovation practices in a developed country context. Hueske and Guenther (2015) highlight the need for future studies, which are more context-specific to better understand what hampers collaborative innovation efforts. The authors called for more research that includes multiple levels of analysis, and context specificity. Accordingly, our qualitative study responded to this call and addressed this research gap. Therefore, our study is limited to analysing data from metals industry suppliers in the UK context. This limitation calls for future research, investigating other manufacturing ecosystems in both developing and developed country contexts to increase generalisability.

Further, we argue that the value appropriation dynamic deals with who gets what from the collective effort generated in the ecosystem (Paton et al., 2021). This includes payback and return on investment but also includes non-monetary returns such as relationships, knowledge, and long-term partnership building. Hence, we call for future research that

investigates the dynamics of innovation ecosystems not only from the focal firm perspective but also from the perspective of suppliers and complementors. Carrying out large scale quantitative research to test some of our key findings would be valuable.

6. Conclusions

There is a need to do more work on addressing the root causes of innovation failure to sustain long-term performance and business viability (Dubouloz et al., 2021; Loewe and Dominiquini, 2006). There has been a significant increase in investment by governments, higher education and industry over the past two decades to achieve innovation targets through collaborative arrangements (High Value Manufacturing Catapult, 2021; Gibson *et al.*, 2019). From an ecosystem perspective, innovation is a distributed activity as it takes place across a large constellation of actors (Jacobides *et al.*, 2018; Bessant and Moslein, 2011). In this study, we extended earlier literature (e.g., Bag et al., 2022; Amara *et al.*, 2016; D'Este et al., 2012, 2014; Bessant and Moslein, 2011) by offering an ecosystem level approach for identifying revealed and deterring barriers to collaborative innovation generation. This research showed that initial managerial perceptions of the barriers, financial and non-financial, might not be sufficient to determine the level of constraints that may be encountered.

An ecosystems lens provides useful insights for us to understand the innovation puzzle more deeply. The ecosystems theory distinguishes between suppliers that feed components into a focal firm/customer, which generates challenges and opportunities for innovation (Jacobides *et al.*, 2018; Adner, 2017). Focal firms are increasingly interested in collaborating with suppliers and SMEs in order to benefit from their ideas and entrepreneurial skills. As a result, suppliers and SMEs are expected to simultaneously create new value and conform to the demands of the focal firms conducive to performing in manufacturing ecosystems (Herrera and Trujillo-Díaz, 2021). Perhaps most significantly, this gives rise to a range of value appropriation problems if not managed effectively in the innovation ecosystem. Importantly, although innovation ecosystems theory focuses on new value co-creation (Millard, 2018; Adner and Kapoor, 2010), we found that there is ambiguity pertaining to *value co-appropriation* set up among the ecosystem actors. To address this puzzle, this study proposes that value co-appropriation is a key dynamic to entice more suppliers and SMEs to participate in innovation ecosystems. Finally, continued study of impeding factors for the generation of

collaborative innovation performance in different contexts will serve to improve our understanding of the dynamics of innovation ecosystems.

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FIGURES

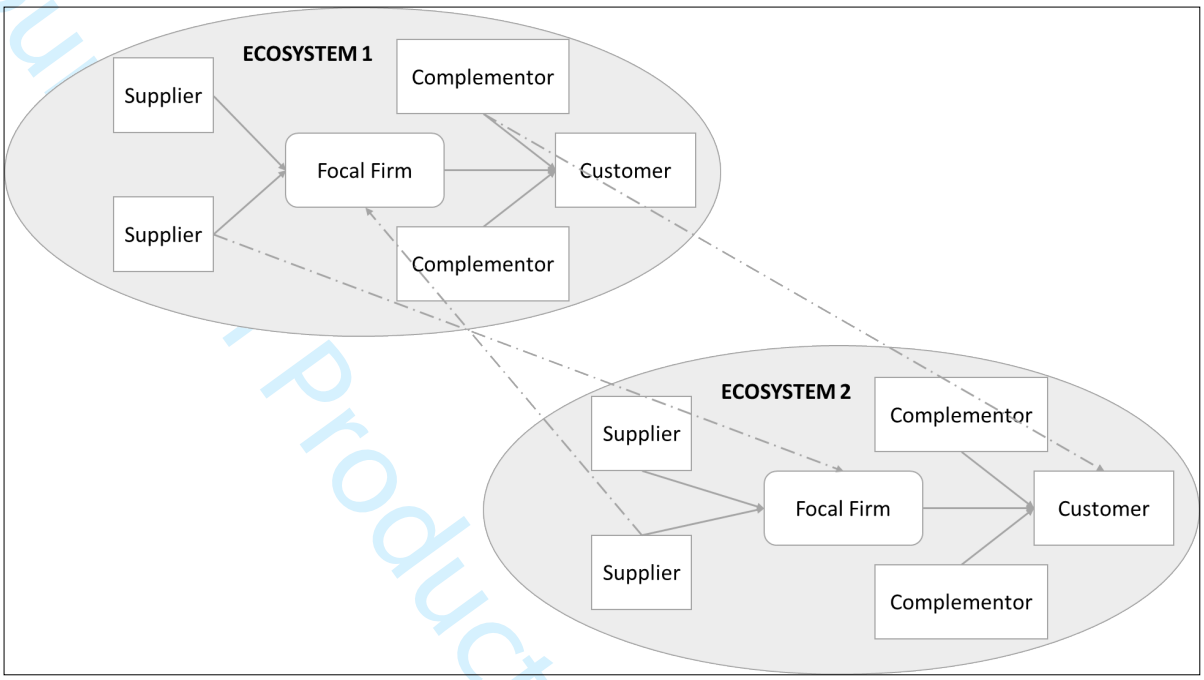

Figure 1. Ecosystem conceptualisation (Adapted from Adner and Kapoor, 2010)

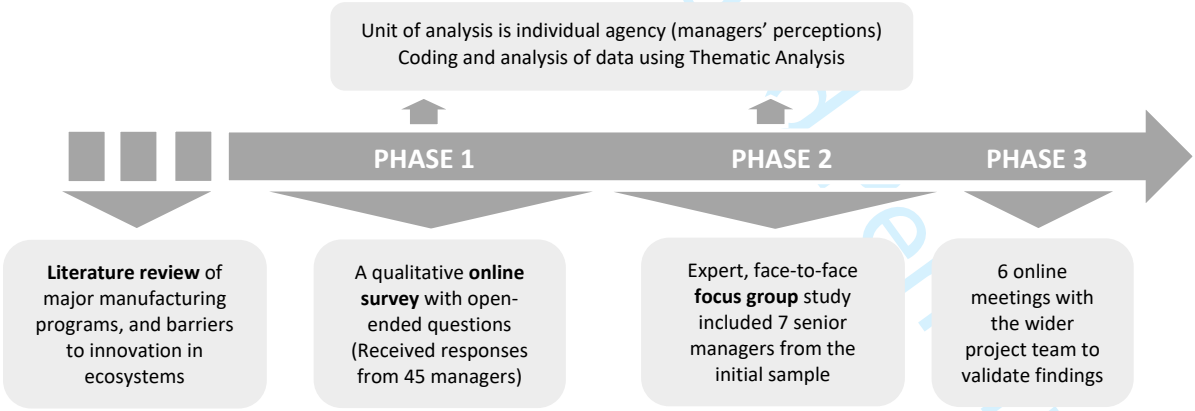

Figure 2. The research process

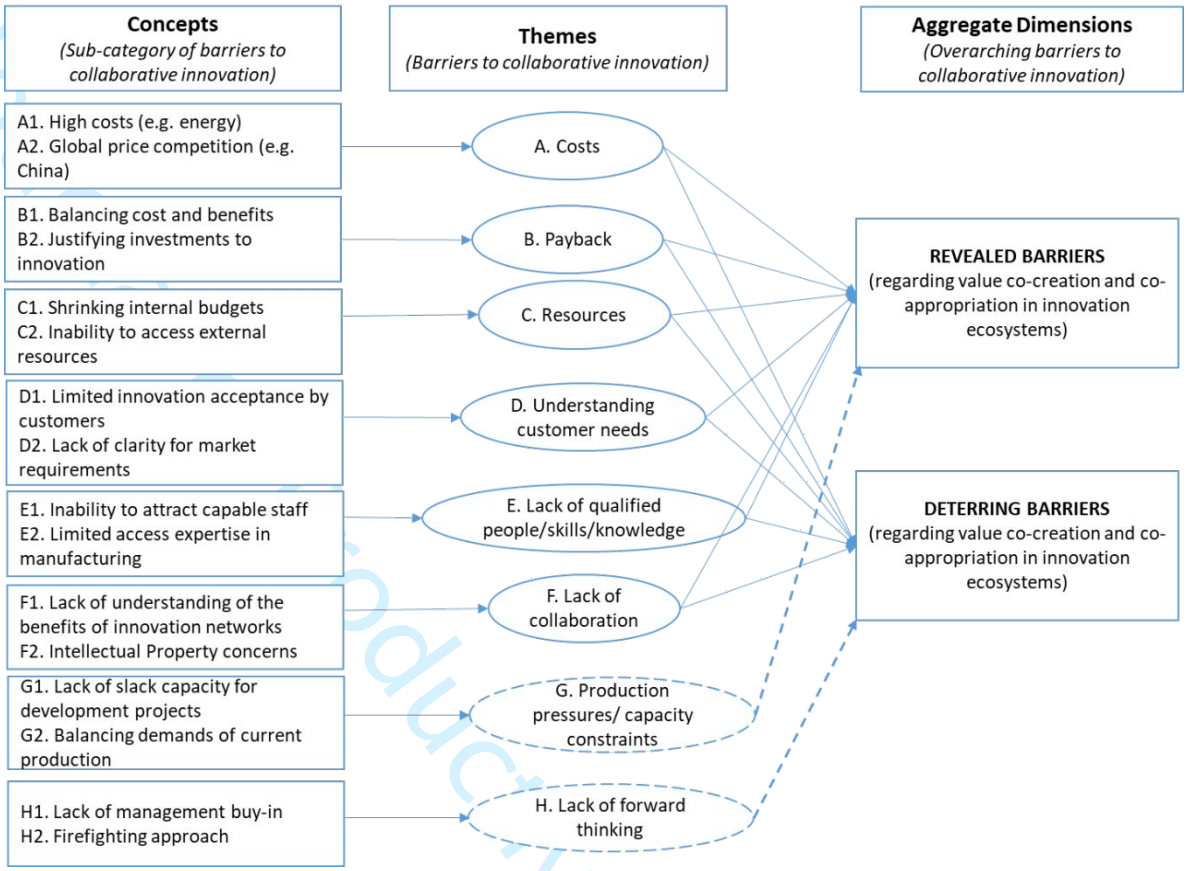

Figure 3. The framework

TABLES

Table I. An analysis of literature on barriers to innovation

Loewe and Dominiquini, (2006)	*Wagner et al. (2011)*	*D'Este et al., (2012)*	*Huang and Chi, (2013)*	*Bogers et al., (2018)*	*Das et al., (2018)*	*Mohammed, (2019)*	*Almpanopoulou et al., (2019)*	*Ghazinoory et al., (2020)*	*Castillo-Vergara et al., (2021)*	*Dubouloz et al., (2021)*	*Bag et al., (2022)*
• Short-term focus • Lack of time and resources • Unrealistic payoff expectations by management • Misalignment between incentives and reward mechanisms to foster innovation • Lack of a systematic innovation process • Belief that innovation is too risky	• Lack of strategy, • Legacy issues, • Lack of time, • Knowledge • Employee empowerment • Past experiences • Existing company procedures	• Cost Factors: excessive perceived economic risks, direct innovation costs being too high, cost of finance, availability of finance • Knowledge Factors: lack of qualified personnel, lack of information on technology and markets • Market Factors: market being dominated by established firms, uncertain demand for innovative goods and services)	• Kinetic barriers • Static barriers	• Endogenous barriers: financial, time, human, technical, information / knowledge • Exogenous barriers: supply-side related (obtaining technological information, raw materials, financing) and the demand side (customer needs and wants, risk perceptions, markets)	• Lack of exploiting new ideas • Inertia caused by local systems architecture • Unsupportive organisational structure • Excessive focus on risk avoidance • Not-invented-here syndrome • No fundamental internal R&D	• Lack of technological support • Lack of investment • Lack of financial resources • High costs attached to innovation • Incompetent business models	• Incumbent actor inertia • Regulation and policymaking ambiguities • Cognitive constraints for opportunity recognition • Institutional complexity	• Lack of training • Lack of R&D • Low technology level • Lack of ecosystem leadership • Lack of skills • Low collaboration ethos • Low-profit margins • Lack of physical infrastructure • Lack of IP protection • Short-termism • Resource constraints	• Environmental barriers • Managerial barriers • Employee barriers	• Internal barriers: lack of financial resources, lack of time, lack of expertise and skills, cultural barriers (tribe syndrome) • External barriers: difficulty in finding partners, bad previous collaborative experiences, administrative burdens of drawing up applications for government subsidies and grants	• Process • Human resource-related • Financial • Collaboration related • Technological • Security • Leadership related barriers

		• Regulation Factors: need to meet the UK Government and EU regulations									
Main contributions: Internal barriers to innovation at the firm level (leadership, processes, tools, culture, values and people/skills related)	*Main contributions:* Knowledge, financial and market/ demand-related barriers to innovation at the firm level	*Main contributions:* Knowledge, financial and market/ demand-related barriers to innovation at the firm level	*Main contributions:* Internal and external barriers to innovation at the firm level Additionally, identified the notion of deterring and revealed barriers to innovation	*Main contributions:* Knowledge, and financial-related barriers to innovation at the firm level	*Main contributions:* Internal barriers to innovation at the firm level (large financial services firms)	*Main contributions:* Knowledge, and financial-related barriers to innovation in SMEs	*Main contributions:* Normative, regulative, cultural-cognitive barriers to the *emergence* of innovation ecosystems	*Main contributions:* Organisational barriers to collaborative innovation at the ecosystem level	*Main contributions:* People and environment-related barriers to innovation and creativity at the firm level	*Main contributions:* Financial, time, technical, human, offer and supply-related and institutional barriers to open innovation in SMEs	*Main contributions:* Identified 27 barriers to innovation in manufacturing firms. These barriers are grouped under seven categories related to internal organisational barriers
Identified gaps:	A better understanding of: 1. The behavioural underpinnings of barriers to collaborative innovation 2. Managerial perceptions in the generation of collaborative innovation performance at the ecosystem level 3. The categorisation of deterring and revealed barriers to collaborative innovation at the ecosystem level 4. Manufacturing suppliers' perspective on barriers to collaborative innovation										

Table II. Thematic analysis of data

Example Evidence	Themes
Revealed barriers to participating innovation ecosystems	
There is a strategic plan, which involves engineers' discussion on the next generation product requirements with designers. However, machine time, resource, cost and operations management's reluctance to change current practices are main issues regarding innovation. We need reduced cost, reduction in waste of all types. Reduction in energy used in processing and improvements in quality and performance. (Respondent #1) Cost can be important but will not on its own deliver high growth. (Respondent #3) For SMEs involved in the metals industry, the interest is usually functionality and cost reduction. (Respondent #3) To stay abreast of the latest processes and equipment with the aim of improved quality and price competitiveness… Gaining market share and reducing costs… (Respondent #5) …resources and cost… making time to do it versus serving our customers today. (Respondent #12) …energy costs are high and we need help to improve our business through cost reduction. (Respondent #12) …cost and lack of awareness of what support is available from government bodies… Cost versus benefit, difficult to see short term benefit of projects. (Respondent #13) Top-level elements include - development and introduction of new materials; development of technologies that provide a step-change in performance; cost reduction opportunities…Balancing of looking at the future with the need to improve performance today… How to reduce time-to-market of new products/materials/innovative ways of working. (Respondent #14) Miscommunications and lack of collaboration between manufacturing & engineering teams working together… Cost & competitiveness. (Respondent #15) Short-term cost focus, fire-fighting. (Focus Group notes)	A. Costs

Cheaper competition from China makes innovation impossible. (Focus Group notes)	
Must justify the return on investment… Innovation that is targeted to real markets. (Respondent #8) …payback on development projects is important. (Respondent #10) …the main issue is funding…Recognisable financial benefits. (Respondent #18) Capital investment and justification through proposed new markets. (Respondent #19) Time taken to bring innovative ideas to production (Focus Group notes) Additional money spent on development [innovation] does not offer real benefit to the company and disrupts customer orders. (Focus Group notes)	B. Payback
A 5-year strategic plan under development with emphasis on value-added differentiated products. The main issues are the shrinking budget for innovation in the company and an inability to successfully leverage external funding opportunities. (Respondent #4) We aim to be collaborative with our customers to improve our products, costs and value add; to explore innovative ways of how the company supplies our customers. Time, cost and skills are the main barriers…design and development of parts to improve material utilisation; balancing short-term results with long-term innovation. (Respondent #11) …resources and cost… making time to do it versus serving our customers today. (Respondent #12) Cost versus benefit; difficult to see the short-term benefit of projects; resource/skills and balancing with demands of production. (Respondent #13) 5-year plan used to scale up components… The main barriers are funding to support research, the infancy of customer relationships… Access to experts in key manufacturing areas. (Respondent #17) Lack of time to dedicate to forward planning and innovation (Focus Group notes)	C. Resources

Lack of long-term plan and dedicated resources (Focus Group notes) Limited access to machines for trials/ lack of equipment (Focus Group notes) Aging demographics and lack of resources for innovation (Focus Group notes)	
A five-year plan is in place, which identifies target aircraft platforms and the areas of development…Identifying gaps in the market and strategic development opportunities are the main barriers. (Respondent #2) Cross-sector collaboration - tech transfer… Need to meet a customer specification/ requirement. (Respondent #6) We currently work with a university – currently, experience good support but main issues are improving customer product through innovation. (Respondent #7) Clarity of market requirement... (Respondent #19) Unable to influence customers. (Focus Group notes) Risk of new products, materials and processes not being accepted by customers or regulatory bodies. (Focus Group notes) Any developments and changes to materials will not be passed by regulations and not accepted by customers. (Focus Group notes) We can't meet customers' increasingly demanding expectations. (Focus Group notes) How to persuade buyers in customer companies as they are focused on issuing a PO [purchase order] rather than innovative ideas. (Focus Group notes)	D. Understanding customer needs
The main barriers are De minimis limits on funding, the inability to recruit high-calibre engineers who not only have the academic ability but the practical application of skills. (Respondent #6)	E. Lack of qualified people/ skills/ knowledge

Skills and engineering resources… previous experience not achieving the results from research that was sought after. (Respondent #9) We aim to be collaborative with our customers to improve our products/costs and value add to explore innovative ways of how the company supplies our customers. Time, cost and skills are the main barriers. (Respondent #11) …resource/skills and balancing with demands of production. (Respondent #13) The main barriers are related to access to experts in key manufacturing areas. (Respondent #17) Difficulty in recruiting skilled people/ limited breadth of knowledge. (Focus Group notes) Lack of skills in engineering, materials and Product Development. (Focus Group notes)	
Cross-sector collaboration - tech transfer… Need to meet a customer specification/ requirement. (Respondent #6) Get more people involved as people do not understand the benefits of innovation networks. (Respondent #7) We need to work closely with OEMs, our customers and military aircraft advancement, keep in touch with SMEs and link between. (Respondent #9) Miscommunications and lack of collaboration between manufacturing & engineering teams working together…Communicate the HVM [High Value Manufacturing] Catapult, what services are offered and how the can the industry get involved. (Respondent #15) Unaware of the details, other than looking at alternative manufacturing processes and materials to be used for future wind turbine shaft & hub components, as turbines get larger there will need to be a step-change in design and process… Difficult working outside of the company to see what new technologies are available… (Respondent #16) Share what support will be offered across sectors working in metal-related fields, publish and who's who of companies and use centres to host networking events to promote an environment for collaboration. (Respondent #17)	F. Lack of collaboration

Identify broader issues and drivers; ensure relevant collaboration on larger issues. Better understand IP issues. (Respondent #19) We don't know how we can protect our know-how and IP. (Focus Group notes) Larger competitors absorb the majority of innovation funding available. (Focus Group notes)	
As stated previously, lack of capacity. Insufficient time to carry out innovation due to production pressures and capacity constraints. (Respondent #5) …balancing day-to-day operations with development activity, payback on development projects. (Respondent #10) …resource and cost… making time to do it versus serving our customers today. (Respondent #12) …balancing with demands of production. (Respondent #13) Limited prioritisation of innovation within a production environment. (Focus Group notes) Pressures to deliver customer goods. (operations always wins the battle) (Focus Group notes) The constant challenge of looking to the future whilst delivering today. (Focus Group notes) Innovating is taking focus away from day-to-day running the company. (Focus Group notes)	G. Production pressures/ capacity constraints
Deterring barriers to participating innovation ecosystems	
…increased pressure from customers to reduce cost is the main barrier to innovation. (Respondent #20) …cost, time and pressure of day-to-day running the business… return on investment, time to gain benefit… resource and support for small companies. (Respondent #33) We are a sub-contractor so do not hold the IP for the design of the product. The process of innovation is hampered by the cost and time to implement changes in our industry. (Respondent #37)	A. Costs

Cost and lack of awareness of what support is available from government bodies. (Respondent #39) Cheaper competition from China makes innovation impossible. (Respondent #45)	
A definitive commercial objective would enhance our innovative activity… (Respondent #25) If we participate in collaborative ventures - how do we protect our know-how? Resource - we have the finite resource & it is a fine balance between cost & benefit. (Respondent #26) Seeing the return on investment, and generating new ideas to take forward as part of innovation, lack of lab equipment to support own research. (Respondent #28) Increase awareness and outline what the benefits can be for companies who need support justifying investment from the parent company. (Respondent #30) Not clear the benefits of some innovative activities, understanding the practicalities and when we would see the benefits. (Respondent #32) …return on investment, time to gain benefit… resource and support for small companies. (Respondent #33) We cannot see clear benefits of some innovation activities… (Respondent #38) Additional money spent on development [innovation] does not offer real benefit to the company and disrupts customer orders. (Respondent #43)	B. Payback
Time resources and customers unwilling to pay for added value… Resources and machines are the main barriers. (Respondent #22) …lack of opportunities with our customers… no facilities available and no innovations coming through on general line products. (Respondent #23) …capital availability within a private company. (Respondent #24)	C. Resources

Resource - we have the finite resource & it is a fine balance between cost and benefit. Developing capabilities to grow into new markets/new products; resourcing of projects (people and £) are other barriers. (Respondent #26) We aim to produce zero maintenance products with a reliable 40-year design life that can work under higher pressure and water depth than previously possible, more justification for products. The main issue is time - every department appreciates the need for innovation but is too busy bringing revenue into the company. Innovation on the back burner. (Respondent #27) …lack of lab equipment to support own research. (Respondent #28) Equipment, software to support further development, time of staff spent not working on orders for customers… Lack of money from the parent company, to invest in new equipment to increase capability and capacity. (Respondent #30) Small SME companies, do not have the spare cash to reinvest into the company to support major innovation programmes. Small staff resource, the key focus is on winning and retaining customer orders. (Respondent #31) …cost, time and pressure of day-to-day running the business… return on investment, time to gain benefit… resource and support for small companies. (Respondent #33) We aim cost competitiveness…Innovation is difficult for an SME…Not easy to obtain funding for small projects that will provide process improvement. (Respondent #35) Aging demographics and lack of resources for innovation. (Respondent #42)	
…customer buy-in for material specification change… (Respondent #20) …lack of opportunities with our customers… no facilities available and no innovations coming through on general line products. (Respondent #23) Unable to influence customers… Working with clients. (Respondent #35) We need to work with customers on innovation projects. (Respondent #38)	D. Understanding customer needs

Work closely with OEMs… (Respondent #43)	
Equipment, software to support further development, time of staff spent not working on orders for customers. (Respondent #30) The main barriers are capable resources, obtaining capable individuals who can develop our closure portfolio. (Respondent #34) Maintaining customer base and adding value to customer products by reducing overall supply cost… Access to expertise and capable individuals… (Respondent #36) We also have a lack of skills in the engineering team. (Respondent #37) The major issue to me is the lack of widespread expertise. (Respondent #40) …Lack of skills in engineering, materials and Product Development… Aging demographics and lack of resources for innovation. (Respondent #42)	E. Lack of qualified people/ skills/ knowledge
If we participate in collaborative ventures - how do we protect our know-how? Lack of awareness of what support is available from the government - too complicated and variable. (Respondent #26) Protecting customer IP, makes it difficult to get involved in Government funded work. Have not looked beyond customer specifications to see what else we could offer, or how to use our manufacturing processes differently…Support for open die forges, look at getting big customer companies involved and engaged with innovation so they are more likely to be willing to explore different processes, specifications for components. (Respondent #29) Collaboration with other industries… Maintaining customer base and adding value to customer products. (Respondent #34) We aim cost competitiveness… Innovation is difficult for an SME… Not easy to obtain funding for small projects that will provide process improvement. (Respondent #35) We need more collaboration with other industries both in the UK and abroad. (Respondent #36)	F. Lack of collaboration

Cost and lack of awareness of what support is available from government bodies. (Respondent #39)	
Management buy-in for the benefits of a change of process… (Respondent #20) Clear direction from upper management decision to pursue innovation projects versus meeting customer deliveries. (Respondent #21) We aim to produce zero maintenance products with a reliable 40-year design life that can work under higher pressure and water depth than previously possible, more justification for products. The main issue is time - every department appreciates the need for innovation but too busy bringing revenue into the company. Innovation on the back burner. (Respondent #27) Small SME company… Small staff resource, the key focus is on winning and retaining customer orders. (Respondent #31) Additional money spent on development [innovation] does not offer real benefit to the company and disrupts customer orders. (Respondent #43) Taking the focus away from day-to-day running the company…We focus on serving our customers better…faster response; forecasting what we need to stock; we are good at firefighting. (Respondent #44) Lack of senior management buy-in to change and innovation. (Focus Group notes) Greater focus on incremental improvement (of product and process). (Focus Group notes)	H. Lack of forward thinking

Appendix I. The Survey Instrument

Questions
CONTEXT
What would you class your company as?
What is the nature of your business?
Have you been directly engaged in collaborative innovation activity in the past?
What are your key issues/ challenges/ barriers regarding innovation?
What do you see as the main drivers for collaborative Innovation?
STRATEGY
Is innovation on the board agenda?
Does your company have an Innovation strategic plan?
If you answered yes to question 5 then please provide details of your strategic plan in the box.
Roughly what percentage turnover do you invest in Research and Development, Innovation?
Roughly what percentage turnover do you invest in Capital Expenditure?
Do you have an on-site Research and Development/ Innovation facility?
Roughly, what percentage of your headcount is 100% dedicated to Innovation?
If you are part of a larger corporate organisation, is there a centralised innovation function?
INNOVATION ECOSYSTEM PARTICIPATION
Have you been involved in any Innovation ecosystems, networks, partnerships or collaborations?
If yes, were they successful? If not, can you indicate the main reason(s) for the lack of success in your opinion?
What innovation activity do you currently undertake?
What Innovation activity are you good at and why?
In your view, what stops you/hold you back from partaking in Innovation activities? Do these factors relate to your direct past experiences or your beliefs?
Do you feel appropriately informed of the collaborative Innovation opportunities available?
For the metals sector innovation ecosystem, what do you think needs to be done?
SWOT
Please complete the SWOT Analysis below for your company, regarding Innovation-Strengths
Please complete the SWOT Analysis below for your company, regarding Innovation-Weaknesses
Please complete the SWOT Analysis below for your company, regarding Innovation-Opportunities
Please complete the SWOT Analysis below for your company, regarding Innovation-Threats