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The co-production of value in digital, university-industry R&D collaborative projects

Ana Isabel Canhoto*; Oxford Brookes University; adomingos-canhoto@brookes.ac.uk

Sarah Quinton; Oxford Brookes University; sequinton@brookes.ac.uk

Paul Jackson; Oxford Brookes University; pjackson@brookes.ac.uk

Sally Dibb; Open University Business School; sally.dibb@open.ac.uk

Abstract

In the context of R&D collaborations between universities and industry, this paper investigates the co-production process and the contextual elements which shape it. A conceptual framework is developed which builds on the Service Dominant Logic proposition that value emerges from the interaction between co-producing parties and the integration of resources. Specifically, the framework explicates how individual, organizational and external factors shape the type of interactions and the platforms used, the availability and use of operand and operant resources, and the organizational and individual outcomes, in R&D collaborative projects. The interplay between these factors is investigated via group interviews with UK industry practitioners and university researchers in the context of digital research projects. The types of interaction, resources and outcomes that characterize successful R&D collaboration, are revealed; and the contextual aspects which enable, facilitate, block or create barriers to successful R&D collaborations, are identified. Five practical principles for the successful development of collaborative R & D projects within the university-industry context are proposed.

Keywords: value co-creation, co-production, university-industry collaboration, knowledge exchange, digital research, R&D collaboration

*corresponding author

1. Introduction

The concept of Service-Dominant Logic (SDL) emphasizes the customer's role in co-creating value with the supplier during exchange, rather than as a passive recipient of value at the end of a transaction (Vargo, Maglio, & Akaka, 2008). Value is therefore created through active interaction between the firm and the consumer (Vargo & Lusch, 2008), or in business to business markets between two firms, and from the integration of resources from both parties in order to create a valued outcome (Gronroos, 2007). The distinction between value co-creation and value co-production is an important one in this paper. Co-creation occurs when the customer takes the firm's value proposition and integrates it with their own resources to generate something the value of which is subjectively determined by the beneficiary (Vargo & Lusch, 2008). Conversely, co-production involves the purposeful integration of operand and operant resources from the firm and the customer, in order to develop a value proposition, which can range from the co-conception of goods and service, to their co-disposal (Sheth & Uslay, 2007). The distinction between co-creation and co-production is dismissed as unnecessary and unhelpful by authors such as Payne, Storbacka, and Frow (2008), who prefer to use the two terms interchangeably. However, other authors such as Etgar (2008), Jacob and Rettinger (2011) and Vargo and Lusch (2008), argue that the distinction is important for the conceptual development of the field. This paper follows the tradition that distinguishes between co-creation and co-production, focusing on the latter in order to focus the reader's attention on the process of development of the core value proposition.

Co-production takes place in a variety of business-to-consumer, business-to-business exchanges, and non-commercial settings (e.g., Alves, 2013; Diaz-Mendez & Gummesson, 2012). It can also be witnessed in the form of collaborative Research and Development (R&D) initiatives between universities and industry, which are the focus of this paper. Idea generation and creativity are both fundamental to R&D, with the latter being an antecedent of innovation (Bozeman, Fay, & Slade, 2013). Both idea generation and creativity are enhanced through inter-personal communication which can be developed within a work place environment (West, 2002).

Although most inter-organizational R&D collaborations occur within the private commercial sector (Rank, Pace, & Frese, 2004), universities are increasingly engaging in technology transfer and exchange with commercial firms and other partners (Bozeman et al., 2013). Their specific characteristics of idea generation and knowledge creation can provide a fruitful locale for R&D collaboration. Such university-industry collaborations can either develop knowledge or create outputs with economic value (Bozeman et al., 2013). For example, Waseda University in Japan collaborated with private Japanese firms to successfully develop and commercialize software (Oh, 2012), while Karolinska Institute in Sweden partnered with the country's bio medical industry to develop specialist courses for the commercial marketplace and created over 40 spin-off firms in the process (Edmondson, Valigra, Kenward, Hudson, & Belfield, 2012). In the US, the University of Utah, collaborated with the gaming industry to restructure the academic offer in order to provide suitably skilled graduates for this growing industry (Caldwell, Kessler, Altizer, & Langefeld, 2012). The collaboration between Imperial College London, in the UK and

multinational firm IBM, focused on the digital economy, leading to the creation of a specialist lab and generating cross-faculty research; whilst the partnership between University of California Berkeley and Nokia, which is focused on developing competitive strategy for Nokia, has resulted in exchanges of researchers, the development of new technologies, and multiple patents and publications (Edmondson et al., 2012). These examples clearly illustrate the high value creation potential of R&D collaborations (Huikkola, Ylimäki, & Kohtamäki, 2013), which is why these partnerships are supported by government policy in many countries (Du, Leten, & Vanhaverbeke, 2014).

Despite the considerable benefits which R&D collaborations can offer, research in the field remains fragmented. In particular, there is a dearth of qualitative insights, and the findings from the few studies that exist provide contradictory views on the individual determinants, organizational incentives and impacts of projects (Perkmann et al., 2013). This is problematic given that many co-production initiatives fail in practice to generate the expected benefits, and in the worst cases lead to 'value destruction' (Crowther & Donlan, 2011). The many challenges that the process of co-production presents are partly to blame. These include selecting partners, developing the relationship, managing the interactions between parties, and implementing project outcomes (Crowther & Donlan, 2011; Grover & Kohli, 2012). Moreover, the context in which co-production takes place influences the exchange, creating a complex and dynamic setting (Akaka, Vargo, & Lusch, 2013; Chandler & Vargo, 2011). Similar issues have been witnessed in R&D collaboration between universities and industry. These include clashes between the academic and the managerial logic (Kitchener, 2002), cultural and communication divides (Edmondson et

al., 2012), and diverse goals, capabilities and epistemological stances (Bansal, Bertels, Ewart, MacConnachie, & O'Brien, 2012). As a result, some collaborative projects fail or have negative consequences for the individual participants, such as fewer publications for academics (Lin & Bozeman, 2006); or for society, due to a failure to disseminate research findings (Perkmann et al., 2013).

This paper advances the conceptual understanding of value co-production and develops a deeper understanding of the management in practice of R&D collaborations. We build on the SDL notion of value as an interactive, multi-actor, exchange process. We unpack the way in which the social and material characteristics of the context, and the attributes of individuals engaging in the co-production of value in R&D collaborations between universities and industry, support or hinder the process. In doing so, we complement and advance conceptual work by Akaka et al. (2013), Chandler and Vargo (2011) and others on the interplay between context and process of value co-production. We also provide qualitative, empirical evidence that is absent from these earlier papers (Perkmann et al. (2013).

Since the conceptual development of this field and its relevance for managerial practice are enhanced when the research is concrete and applied to a definite setting (Chang, Chih, Chew, & Pisarski, 2013), we focus on the specific case of R&D projects in the digital arena. Digital research is a subject area of interest and importance across both industry and university environments (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013). The interdisciplinary nature of research in the field offers multiple streams of enquiry, from

computer science to sociology, and including marketing and information systems, which benefit from distributed innovation (Yoo, Boland Jr., Lyytinen, & Majchrzak, 2012) and inter-organizational partnerships (Bharadwaj et al., 2013) which transcend established subject or functional silos. Furthermore, while it is clear that universities can transfer knowledge that supports innovation to industry (Pertuzé, Calder, Greitzer, & Lucas, 2010), in the case of digital research the reverse is also the case; for instance, industry has developed new techniques and protocols to collect, manage, analyze and distribute digital data (Ruppert, Law, & Savage, 2013). This represents a significant departure from the traditional discourse on university-industry R&D collaboration, which tends to describe universities as providers of knowledge and technology, and industry as providers of funding, materials or data (Bozeman et al., 2013; Perkmann et al., 2013).

The paper addresses the following research question: '*How do the various contextual layers shape the co-production of value in university-industry R&D collaboration, in the digital arena*?' We draw together literature on the process and role of context in value co-production and on R&D collaboration as the basis for a research framework for understanding co-production in R&D projects. This is followed by an explanation of the empirical data collection and the presentation of our findings, in which we draw on the verbalized experiences of practitioners and academics. The theoretical implications are outlined and five practical principles for the development of R&D projects between universities and industry are presented.

2. Theoretical background

The starting point for our conceptual framework is the SDL emphasis on process (Vargo & Lusch, 2004) This focus draws attention to the integration of key resources via a series of interactions, in order to define and deliver a mutually valued outcome (Perks, Gruber, & Edvardsson, 2012; Prahalad & Ramaswamy, 2004). This integration can occur at various levels, each of which frames the derivation and evaluation of value (Akaka et al., 2013): from dyadic interactions between individual actors at one extreme to complex service networks at the other. The sub-sections that follow explore how these contextual layers influence the interactions, resources and outcomes that constitute the co-production of value in R&D collaborative projects (see Figure 1).

2.1 The constituent elements of the co-production process

The SDL literature suggests that value emerges from the interaction between co-producing parties through purposeful, continued, encounters that take place over time (Gronroos, 2011). Engagement platforms play an important role in facilitating this interaction (Ramaswamy & Gouillart, 2010); for example, organizations increasingly use online communities and other web-enabled spaces as platforms to connect with different stakeholders (Ngugi, Johnsen, & Erdelyi, 2010; Vernette & Hamdi-Kidar, 2013). In instances where online collaboration generates frustration, particularly when there is no sense of community or participants are perceived to be unfairly treated (Gebauer, Füller, & Pezzei, 2013), face-to-face contact can be more conducive to dialogue and intensive interaction (Crowther & Donlan, 2011). Payne et al. (2008) conceptualize the interactions between parties as a series of touch points that produce value cumulatively and involve

various departments at different stages of the relationship. Although these authors base their findings on business to consumer interaction, their views about how value is generated are also relevant to co-production between organizations. For instance, Lambert and Enz (2012) refer to the need to implement cross-functional business processes that facilitate the sharing of information, encourage engagement, enable progress monitoring and measure project success. Similarly, Perks et al. (2012) note the existence of multiple, micro-level patterns of behaviors, each producing incremental progress that eventually leads to a significant outcome; while Lempinen and Rajala (2014) explain that it is necessary to clarify roles in the process and understand how these alter over time.

Perkmann et al. (2013) review of university-industry relations, identified a broad range of R&D collaboration formats, ranging from simple, ad-hoc exchanges of advice to formal, ongoing interactions that are formalized via contracts (Perkmann et al., 2013). In some cases, such as Science Technology Parks, the collaborating parties co-locate geographically, in order to facilitate communications, the sharing of service, and networking opportunities (Corsaro, Ramos, Henneberg, & Naude, 2012). A common factor that underpins these different formats is that they all aim to produce knowledge (Bozeman et al., 2013). Cross-disciplinary collaboration (Bharadwaj et al., 2013), which can add complexity to the interactions (Corsaro et al., 2012), is also a common theme.

Resources are a central tenet of SDL. They are integral to the production of value and essential for creating competitive advantage (Vargo & Lusch, 2004). These resources are classified into two types: operand and operant (Madhavaram & Hunt, 2008). Operand

resources are typically tangible and static (Edvardsson, Tronvoll, & Gruber, 2011), and require an action to be performed upon them in order to generate value (Vargo & Lusch, 2011). Examples include raw materials or physical products over which the collaborating parties '*have allocative capabilities*' (Arnould, Price, & Malshe, 2006, p. 91). In contrast, operant resources are processional and dynamic (Edvardsson et al., 2011), and are able to act upon operand resources as well as on other operant resources (Arnould et al., 2006)rno. They include organizational competencies, capabilities and routines, the skills and knowledge of individual employees, and the relationships that exist with key stakeholders (Edvardsson et al., 2011). In R&D collaboration, human capital is regarded as the key resource (Bozeman et al., 2013). Although the exchange of data and materials are necessary requirements for innovation projects (Perkmann et al., 2013) and funding must be in place for them to happen, a distinguishing feature of these R&D collaborations is that all parties provide some form of knowledge (Bozeman et al., 2013). This reflects the centrality of creative ideas to all innovation activity (Janssen, Vliert, & West, 2004). Consequently, the human capital that is required for R&D collaborations needs to have particular characteristics. Collaborating partners need to bring knowledge that is new and complementary to the organization (Chesbrough, 2003). The scope of the knowledge base is also crucial, with some evidence indicating that initiatives based on narrow knowledge bases are the most likely to succeed (Un, Cuervo-Cazurra, & Asakawa, 2010). Individuals with several skills who are able to play multiple roles are particularly desirable (Rese, Gemunden, & Baier, 2013), as are those with strong social and communication skills (Diaz-Mendez & Gummesson, 2012).

The final constituent in the successful co-production of value relies on both parties benefitting from the collaboration and having their expectations met (Pinnington & Scanlon, 2009). Economic and financial gains, such as price reductions or savings in production costs, are among the prime benefits that organizations seek (Ulaga, 2003). Functional benefits, such as product features that delight customers (Mattsson, 2010), or reductions in the time and effort required to acquire the product (Saarijarvi, 2012), are also sought after. The individuals engaged in the co-production process may also derive economic and functional benefits in their own right, such as improving their personal knowledge of the market or strengthening their capacity to solve problems (Ulaga, 2003). Individuals can also gain emotional benefits, such as feeling empowered by being actively involved in the construction of value (Verhoef et al., 2009); and symbolic benefits, such as being able to express themselves through their engagement in the co-creation process (Rintamäki, Kuusela, & Mitronen, 2007).

A number of benefits from R&D collaborations exist at the institutional level. For industry, the primary benefit is the access which is gained to leading edge (rather than applied) research (Lambert & Enz, 2012). For universities there are twin pressures: a growing need to demonstrate the impact of academic research, and a financial imperative to identify alternative funding sources (Du et al., 2014; Edmondson et al., 2012). Yet there is a dearth of research evidence concerning the motivations and working methods of individuals engaged in R&D collaborations (Walshe & Davies, 2013). The only work that we could identify, suggests that some individuals may feel '*positively charged (by) ideals of creating*

"an exciting future"" (page 30), and by engaging in activities that they feel support this future (Lawrence, Suddaby, & Leca, 2011).

2.2 The contextual aspects of co-production

The interactions, resources and outcome that make up the co-production of value are likely to vary according to the context in which co-production takes place (Edvardsson et al., 2011). The conceptualization of value as subjectively determined and produced – i.e. value in context rather than value in use - draws attention to the context in which the co-producing partners interact (Vargo & Lusch, 2011). Drawing on Chandler and Vargo (2011), we consider context in terms of a set of actors and the unique reciprocal links existing between them, such that different sub-sets of actors and their connections constitute different contexts. These contexts range from the single actor level, to dyads, triads, complex networks, and service ecosystems (Akaka et al., 2013; Corsaro et al., 2012). In relation to R&D collaboration, Bozeman et al. (2013) identifies three layers each of which we consider in turn and which we integrate into our research framework: individual collaborators (the individual level), the organizational home of each of the collaborators (the organization level), and the policy and market context that surrounds them (the external level).

By virtue of their positions and roles within the project (Edvardsson et al., 2011), individual collaborators act as 'resource integrators' (Vargo & Lusch, 2008). Individual participation in R&D collaborations often results from previous personal contacts or interactions between the parties (Edvardsson et al., 2011). The likelihood of participation and future

collaboration behavior are both influenced by the individual's previous experience of such projects (D'Este & Patel, 2007). In addition to the specific project role that they play, individual collaborators act as boundary spanners between the project, the organization that hosts or employs them, and their wider context, such as the industry or academic discipline to which they belong (Corsaro et al., 2012). Evidence suggests that the behaviors and expectations of these individuals is shaped by their organizational home by virtue of social norms and organizational values (Edvardsson et al., 2011). The nature of organizational support and the incentive systems that are available can also influence R&D collaborations between university and industry (Perkmann et al., 2013). Sometimes the impact of these factors is negative. For instance, Audretsch et al. (2002) found instances where university administration was committed to R&D partnerships with industry, but bureaucracy sabotaged those goals.

In cases where the different organizational homes have congruent values and norms, collaboration is less likely to be successful (Akaka et al., 2013; Solomon, Surprenant, Czepiel, & Gutman, 1985). At face value, this argument apparently supports co-creation between academic and industry institutions, the social contexts for which are largely incongruent. However, the conflicting pressures which are a consequence of these differences, such as whether relevant resources can readily be accessed (Un et al., 2010) or if the results of an R&D project can be published (David, 2004), can create barriers to progress. Since universities traditionally have a broad knowledge base (Henard & McFadyen, 2006), they are able to act as knowledge brokers between firms in different industries. Furthermore, in their role as educators, they have established mechanisms to

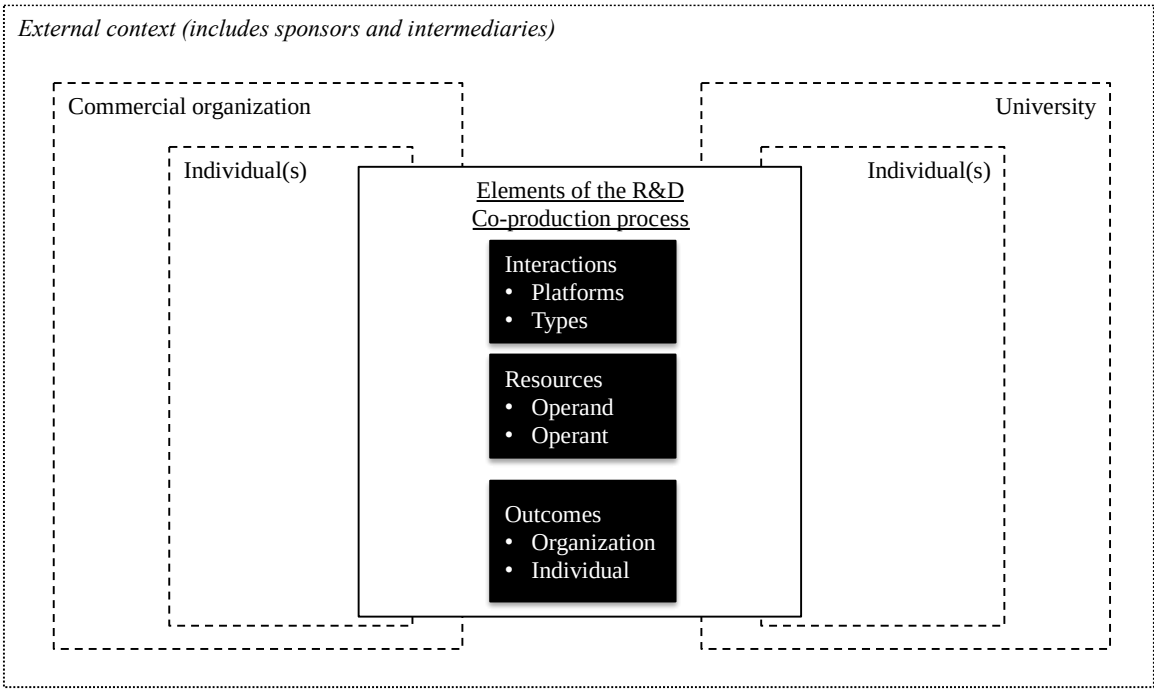
transmit and facilitate access to that knowledge base (Agrawal & Henderson, 2002). In contrast, industry players often have a narrow knowledge base that is limited to their own markets (Du et al., 2014), and their mind-sets may resist giving others access to their resources (Un et al., 2010). While there is evidence that the most successful collaboration projects are those that adopt a relatively loose and informal management style (Kitchener, 2002), achieving this informality of approach is not necessarily straightforward. For example, a lack of stability and autonomy on the universities' side may hinder collaboration with industry (Un et al., 2010); and clashes between academic and managerial logic can undermine the success of collaboration attempts (Edmondson et al., 2012).

The third and final contextual layer is the ecosystem in which these organizations and actors are embedded (Akaka et al., 2013), and to which they are connected by value propositions (Vargo et al., 2008). This ecosystem impacts upon R&D collaborations in several ways. For instance, national policies and the allocation of funding shape the collaborations that take place (Perkmann et al., 2013); national attitudes to innovation can indirectly influence the level and rate of innovation (Janssen et al., 2004); and societal values, such as in relation to climate change or the importance of quality, help determine how innovation is focused or the collaboration partners that are selected (Ngugi et al., 2010). The ecosystem also includes project sponsors, who can impose organizational forms or inventive systems which directly influence the effort invested in a project (Raasch & Hippel, 2013); and intermediaries, who may enable communication and interaction between the partners (Bansal et al., 2012).

The conceptual framework we use to shape our study is shown in Figure 1. An outline of the empirical study which explores these factors is explained below.

Figure 1

Framework of co-production in university-industry R&D collaboration



3. Research design

As the co-creation of value is manifested through interaction, our empirical investigation adopted a social-constructionist approach. Social constructionism focuses on understanding the social processes by which phenomena assume their form (Denzin & Lincoln, 2012) and is thus a suitable lens to study co-production (Corsaro et al., 2012;

Edvardsson et al., 2011). Such an approach is needed to provide the in-depth insights missing from other studies examining co-production between universities and industry (e.g. Un et al. (2010) Du et al. (2014). In line with Lambert and Enz (2012), we focused on the individuals that engage in collaborative initiatives, rather than at the organizational level. Moreover, following Huikkola et al. (2013), our investigation included both sides of the R&D relationship, namely research participants from industry as well as from universities.

Echoing previous research in small business (Yoo et al., 2012) and knowledge transfer (Paraskevas & Saunders, 2012), our sampling approach used diverse but expert participants. We build on the findings of Perkmann et al. (2013), who suggest that disciplinary affiliation strongly influences academics' engagement with industry partners. Participants were drawn from a heterogeneous group of UK professionals, encompassing: academics from established and new universities; computer scientists; small and medium business owners; senior level managers from large firms; managers from public sector organizations; managers of technology transfer and business development functions within universities. To ensure their suitability, all participants had R&D experience within the field of digital research. Accessing a spread of experiences within R&D collaborations enabled a rich and holistic picture of the co-production of value in university-industry relationships.

Data were collected via group interviews, an approach that is recommended for studying interactions between research participants (Frey & Fontana, 1991). Following guidance

from Barbour (2007), 36 individuals were interviewed in six groups, each of which comprised roughly equal numbers of industry and university participants. Using mixed groups minimizes the chances that participants might be working with hidden assumptions (Rose, Spinks, & Canhoto, 2014), thus making the implicit explicit. The group interviews focused on participants' experiences of successful R&D collaboration in digital research. The interviews proceeded by exploring the following topics. First, participants were asked to identify the most valued outcomes. This was followed by a discussion of the type of interactions that best support R&D collaboration, in which issues such as form, frequency and the role of technology were considered. The operant and operand resources required for successful R&D collaboration were explored next. A systematic process for surfacing the contextual elements in the process was followed in each group interview. Whenever a participant referred to the impact of factors such as organizational rules or ways of working, the group moderator directly questioned other participants about whether they had similar experiences.

The interviews were filmed and contemporaneous notes were recorded in notebooks and on flipcharts, enabling participants to confirm that their contributions had been understood (Mero-Jaffe, 2011). The video recordings were transcribed and anonymized, to protect the privacy of the participants and the strategic interests of their organizations. Interview notes, transcripts and flipcharts were analyzed using thematic analysis (Bryman, 2012; Denzin & Lincoln, 2012). Two researchers separately coded the transcripts while a third sampled the combined coding to check consistency, saturation of pattern matching, and ensure internal validity (Boyatziz, 1998; Fereday & Muir-Cochrane, 2008). The coding process followed

Krippendorff (2004) systematic approach. Following initial classification according to participant type, two stages of data categorization followed: (i) the data were interrogated inductively to identify emerging themes; and (ii) the data were classified into the component elements of the co-creation process, namely 'interaction', 'resources' and 'outcome', and according to contextual level, namely 'individual', 'organization' and 'external' (see table 1).

Table 1.
Example of coding process of the group interview extracts

Inputs *Verbatim Quotes*	**Type of participant** *Labels:* • *Academic* • *Practitioner*	**Stage 1** *Inductive labels*	**Stage 2 – Process components** *Labels:* • *Interaction* • *Resources* • *Outcome*	**Stage 2 – Context levels** *Labels:* • *Individual* • *Organization* • *External*
There should be an allowance or an expectation of the unexpected, the counter-intuitive. Because if you give people space to think, people will come out with all sorts of ideas. (Participant 13)	Academic	Time to think; Space to think; Acceptance; Creativity; Employer;	Resources	Organization

During the following stage the researchers noted the patterns and repetitions in the data and, following the process outlined in Miles and Huberman (1994), distilled these into emergent categories.

4. Results

The key findings from the interviews are summarized in table 2 and described below.

Table 2

Key process and context factors in R&D collaboration

		Elements		
		Interaction	**Resources**	**Outcome**
		Build momentum Develop trust Work flows	Funding Technical, creative, and communication skills Attitude	Functional and emotional benefits for individuals Financial and functional benefits for organizations
Context	**Individual**	Shared purpose and understanding; Regular (face to face) interaction; Experience of working together; Long-term view; Individual preferences.	Complementary skills; Interest in innovation; Open minded; Realistic expectations.	Offering different perspectives; Seeking complementary approaches;
	Organisation	Role of legal departments; Ways of working.	Offer space and time to think; Risk taking environment; Interaction with other activities in the organization; Different timescales; Awareness of, and accessibility to, each other's work.	Conflicting demands on time; Conflict with other goals.
	External	Development of networks; Administrative burdens.	Key sources of funding.	Push for cross-discipline research; Focus on functional outcomes.

4.1 Key aspects of interaction, and how they are shaped by the context

Building momentum was seen as key to successful collaboration between universities and industry. Interviewees achieved this momentum by moving quickly beyond generic ideas to agreeing on specific goals, identifying needs and agreeing the critical points in the project. This pragmatism had to be balanced with the creation of a working environment that allowed for new ideas, including those that might challenge conventional practice, to be fully considered:

> *There is a big, big, big gap between having the ideas and actively developing a research project… We need to identify practical, doable, achievable research projects. It has to be brought down to specifics… Identifying the specifics of each project is a must.* (Participant 26, Academic)

> *When you get these people together, they will have lots of ideas. Some of them (are) crackpot. Some of them will go nowhere. Probably the majority will go nowhere. But there might be an idea that looks crackpot and but actually turns into the next big thing. You need to think about how you allow that to happen without dismissing things at such an early stage that they do not get developed.* (Participant 13, Academic)

A favored approach for balancing the need for pragmatism and innovative thinking was to encourage creativity within well-specified boundaries:

You need to keep the big problem in the background, then the specific problems are like models of the bigger picture. Our outputs are these very specific things that help with the big problem. (Participant 7, Academic)

Trust was identified as another key factor. As trust could not be imposed externally, partners needed to have time to get to know each other, for the relationship to develop and to find the best way of working together. Interviewees commented that it was advantageous to meet regularly, in order to exchange information or work together on specific aspects of the project. There were differing views on the extent to which technology could facilitate such contact. Some participants believed that communication via broadband and web conferencing supported joint working between talented individuals, while others were more skeptical about the benefits of online communication:

Trust is fundamental to the way we work… but we can work remotely and do not need to meet in person for trust to develop. We can use technology. That is the nature of trust in the digital environment. (Participant 4, Practitioner)

Developing trust is essential for us. But what is the best way to do that? Do we need to meet face to face? Yes. And this is costed in the project. (Participant 1, Practitioner)

Some people think that broadband connectivity is a necessity to be able to work together. But you can do it without connectivity and without the technology that is

now emerging. People have always innovated and done great things without broadband. (Participant 29, Practitioner)

It was seen as important for partners to develop simple mechanisms and processes that improved communication, and allowed for rapid information exchange. This process included establishing clear roles in the teams and investing time early on to understand each other's terminology. All participants had experienced projects where a misunderstanding of the expectations or interests of partners had hindered progress. In the words of one academic:

We sometimes think that we are talking about the same thing and we are not. At [a previous initiative], we didn't get beyond the language and the meaning of terms, which you have to if you are going to have real collaboration. (Participant 8, Academic)

Project success requires that individuals have a shared purpose, understand each other's motivations, and believe in each other's commitment and abilities. In addition, working together on small projects before embarking on larger initiatives, was deemed crucial to developing trust:

There are stages in this. Maybe start with requirement to produce something and realize that people are reliable and deliver and are interested. Small projects are the way to get going. (Participant 2, Practitioner)

Individuals had to approach collaboration with a long-term view. Some projects were unsuccessful and exploratory meetings did not always lead to a joint project. Even so, such contacts were considered a useful basis for establishing connections and generating future collaboration: "*Past successes and failures feed into how you shape and develop, and generate new ideas and opportunities*" (Participant 13, Academic).

Individual preferences affected how and with whom participants worked. For instance, a preference for face-to-face contact meant that some participants favored working with institutions that were geographically local, even if they did not have the highest reputation in the field: '*You'll do business within 2 hours' car drive*' (Participant 3, Practitioner).

Project interactions were often shaped by organizational context. The requirement for legal departments to formalize arrangements early in the process could get in the way of developing a relationship. Other legal barriers designed to protect the organization's intellectual property (IP) created delays and an environment of suspicion that discouraged many researchers from pursuing collaborative initiatives. All types of participants shared a similar frustration, as encapsulated in the following quote: '*The biggest barrier to innovation is IP offices!*' (Participant 3, Practitioner). Different ways of working could also influence the development of workflows and timescales:

> *Practitioners have this drive to take the idea and run quickly with it, to see if it works. But for academics there is this need for incubation and maturation of the ideas that are put forward*. (Participant 13, Academic)

R&D projects are often sponsored by third parties, who play a defining role. On the one hand, institutional bodies such as Innovate UK (formerly the Technology Strategy Board), pan-institutional research initiatives such as those funded by the European Commission, and think-tank organizations, were seen as a positive factor in bringing together different types of researchers and institutions. Most sponsors require regular progress reports and financial statements, which can be a time consuming and distracting '*administrative nightmare'* (Participant 18, Academic).

4.2 Key resources and how they are shaped by the context

A range of necessary resources was identified by participants. Funding was seen as the basic enabler of R&D projects by all of those taking part, but the sources used and the difficulties faced varied. While universities rely mainly on highly competitive external sources, industry participants typically seek internal financial support for collaborative projects, a process which is rarely straightforward.

Successful projects also require a range of different skills, ranging from the ability to contribute good ideas to the need for particular advanced technical skills. Being able to assemble teams of people with different and complementary skills was therefore deemed essential:

> *You need to have the knowledge of where the industry is going and the courage of taking a viewpoint. And we need people able to interpret data, but also people able*

to tell a story about that data. It is really difficult to find people that can - or, indeed, want to - do both. It is almost bipolar skills. (Participant 1, Practitioner)

We don't say "I can't do that because we haven't got the (technical) skills or the data". In the world we are in now we just say: Let's go and find a partner. We connect and find the knowledge. (Participant 3, Practitioner)

Partners had to have a genuine interest in interacting with others, and needed to believe that they would benefit from the partnership. They needed to be enthusiastic about new ways of solving problems and curious about innovation. Being open-minded and willing to learn from the other party were also important, as these participants explained:

It takes a certain type of person. Someone who is going to be open and transparent with you. Someone who has a stake and commitment to deliver. (Participant 3, Practitioner)

I am a bit of a magpie. I like shiny things. Anything that is new, that is interesting. And that I can make money from for my business. (Participant 2, Practitioner)

You don't form a partnership by approaching it from a position of power, but from curiosity. It is not about celebrities. (Participant 6, Academic)

Participants stressed the need to be realistic about the difficulties of working in a collaborative environment, as different ways of working, varying priorities and expectations could all cause tension:

> *Collaboration is quite hard, even with the person next to you in the office. Collaboration is very difficult across disciplines and across sectors. We need to go in with the assumption that it's a difficult enterprise.* (Participant 8, Academic)

Reflecting on the kind of organizational context that supports R&D, all participants felt that having the necessary space and time to think and develop their ideas was crucial. Some mentioned Google as an example of good practice, where employees are encouraged to invest 20% of their time pursuing innovative projects. In addition to having sufficient time, and an environment which encourages experimentation and risk taking were also deemed important:

> *There should be an allowance or an expectation of the unexpected, the counter-intuitive. Because if you give people space to think, people will come out with all sorts of ideas.* (Participant 13, Academic)

Moreover, the process of academic research, which must usually be scheduled around teaching requirements and administrative commitments was not always compatible with industry timelines. The requirement for numerous institutional approvals compounded

these difficulties, putting academic partners out of step with industry's emphasis on speed and action:

> *One of the main challenges (is) the differences in timescales. For (businesses) it is very fast paced, very fast moving and the decisions are needed yesterday, almost. (We need to) make sure that businesses and academia coincide at the right point so that they can really capitalize on the knowledge*. (Participant 17, Practitioner)

Even the best-intentioned, well-supported and most determined researchers faced major difficulties in gaining access to, or developing a good understanding of, each other's work. High quality industry-based research may be ignored by academics because it lacks quality signals equivalent to the academic peer-review system. In turn, academic work tends to be published in journals that may not be freely accessible to managers. Instead of routinely reading academic journals, these managers were more likely to use free resources available on the Internet.

> *It's actually quite difficult. How do we find out, if I am working in this area, that you are working in that area?* (Participant 7, Academic)

> *Businesses head to the Internet to find answers. Academics need to be on Twitter… and blog, and be on slideshare and write one-page summaries to make research available to businesses.* (Participant 2, Practitioner)

The main way in which third parties' resources contribute to R&D collaboration is through research funding. Traditionally in the UK, such funding has been sourced through research councils, though increasingly researchers seek financial support from commercial partners, which in its own right is increasing the significance of these collaborations.

4.3 Key outcomes and the context that shapes them

The group interviews identified a range of functional and emotional benefits for individuals involved in R&D collaboration, and a series of financial and functional benefits for their employers. Perhaps surprisingly, each party had a poor understanding of what the other would value. The industry participants, for example, believed that universities are motivated by the opportunity to see how industry works, in order to validate theoretical concepts and source teaching materials. For academics, however, the ability to demonstrate the policy and practice impacts of their research was a primary concern. In recent years the impact of research on non-academic audiences has emerged in the UK as a key performance metric for government and the major research funding bodies. Collaboration with industry was seen as an effective way to create such impact, allowing academic researchers to identify research priorities and develop their ideas in collaboration with the potential beneficiaries of their work. The early inclusion of these stakeholders in a project is particularly beneficial in the field of digital research because it enables a simultaneous understanding of the technology, its users, and the social implications that arise.

> *How can you research (these topics) if you don't approach it from multiple disciplines and multiple perspectives? The best research in this area is problem focused, not discipline focused.* (Participant 8, Academic)

The academic participants perceived that industry partners were motivated by the desire to gain access to specialist academic expertise. Concerns were expressed that commercial organizations were, in some cases, using the partnerships to gain access to know-how at little or no cost. Yet industry participants claimed that their aims were to obtain some sort of operational advantage that could be translated into additional profit or other tangible measures of success:

> *A commercial organization is going to look at deriving some kind of commercial advantage and profit. It says, "Yes, we have succeeded". And the third sector organizations, too, are saying, "If we derive this outcome, we have succeeded".* (Participant 12, Practitioner)

> *There is this old thinking that academia is a service to businesses.* (Participant 6, Academic)

In terms of the benefits derived by individuals participating in collaborative projects, both parties mentioned the opportunity to obtain a different perspective on a particular problem. All participants felt that it was beneficial to bring academics and practitioners together, because they had different expertise and approached problems in different ways. While the

academics felt that they benefitted from the practical insights which practitioners could offer, the industry participants valued the broad knowledge base of the academics and appreciated their ability to approach questions in an abstract way:

> *In universities, you are focused on research problems. You do not have non-research objectives. The business partner brings that.* (Participant 7, Academic)

> *We don't know what we don't know and that's where it is useful to have partnerships with universities because they think laterally and not about solving specific problems.* (Participant 3, Practitioner)

Both sets of participants had experienced frustration in bringing new ideas to fruition within their own workplace settings. For academics, the times pressures imposed by teaching and committee work sometimes hindered their ability to achieve project goals; while practitioners could find research ideas thwarted if they were deemed to threaten an existing revenue stream, or did not offer immediate competitive advantage. An additional complication was that external sponsors placed demands of their own on projects, perhaps driven by a focus on particular functional outcomes:

> *The funding drives the topics because the sponsor wants something specific. Often, it is focused on the technology or the economic aspects, whereas the big problems are broader than that.* (Participant 14, Practitioner)

5. Discussion

This paper has investigated the contextual layers that shape the co-production of value in university-industry R&D collaboration in the digital arena. Using an SDL lens, we have examined the interactions, resources and outcomes that characterize the co-production process in R&D projects, and considered the effects of the individual, organization and external contexts on project success. Our findings shed light on the types of interaction, resources and outcomes that characterize successful R&D collaboration. Firstly, in line with Hoffman, Kopalle and Novak (2010), we have found that successful collaboration requires highly committed individuals, with similar attitudes and complementary skills. We have also shown that individuals came together for specific projects, each playing a particular role and interacting in ways that enable creative and pragmatic balance. The incremental development of mutual trust required regular meetings between partners, though we found that respondents' views varied on the need for geographic proximity. In line with earlier work, it was the practitioner respondents rather than the academics who emphasized the value of geographic proximity between partners (e.g., Antonelli, 2000; Huikkola et al., 2013; Siegel, Westhead, & Wright, 2003). Although this emphasis on the location of partners may seem surprising in the context of digital research; our findings are consistent with previous research on R&D collaboration, which shows that while academics routinely engage in international collaborations, industry tends to favor partners who are geographically close (see Bozeman et al., 2013). It is significant that these findings contradict UK government policy which focuses collaborative funding on a small number of universities with a reputation for research excellence (see Edmondson et al., 2012).

Both academic and practitioner partners were readily able to identify benefits in co-producing value, supporting Pinnington and Scanlon (2009) assertion that sustainable co-production derives from perceptions of worth. Both parties understood and were able to articulate from their own viewpoint the potential benefits to be gained from collaborating (Ulaga, 2003), although each was less clear about the benefits desired by the other. Reflecting Kitchener's (2002) comments about the differences between managerial and academic logic, industry tended to focus on short-term outcomes, whereas universities emphasized the long-term. In line with the study by Un et al. (2010), the participants also recognized that benefits could be generated from the unequal knowledge distribution within and between universities and industry. The complementarity of knowledge sources was seen as important, with both knowledge breadth and depth deemed necessary to co-create value in R&D collaborations. The ability to communicate the project between the collaborating parties was another area that participants emphasized, thus endorsing Diaz-Mendez and Gummesson (2012)'s argument about the value of generic skills in creating value through co-creation.

Through our analysis we have revealed the positive and negative influences on R&D projects of a number of contextual elements (see Table 3). For instance, through the provision of funding and by facilitating collaboration in multidisciplinary projects and networks, external parties can act as key enablers that have both a positive and determining effect on R&D. However, the emphasis they place on administrative requirements and functional outcomes are potential hurdles to collaboration. Those playing the role of individual 'resource integrators' (Vargo & Lusch, 2004) were deemed to have only positive

effects on the collaboration, though the fact that the interviews focused on success stories from the viewpoint of individuals who participated in the projects, is a source of potential bias. The combination of different types of knowledge and skills (Ahuja, 2000) was deemed particularly important by those we interviewed, supporting earlier findings about the impact of relationship building on valuable collaboration outcomes (Vernette and Hamdi-Kidar (2013). Moreover, informal styles of management which gave individuals participants autonomy over decisions were viewed as more conducive to positive outcomes (Du et al. (2014).

We found the role of organizations within collaborations to be more complex. While support for R&D in principle, and in practice, is an enabler of collaboration, the success of such ventures often happens in spite of the management arrangements in place. The existence of highly formalized and systemized approaches to manage collaborations was a constraining factor. In line with Bruneel, D'Este and Salter's (2010) study, the university administrative systems for IP (Intellectual Property) were a particular hindrance to the process of co-producing value. A further difficulty could be in accessing knowledge produced by universities. Even though universities' role in society is to produce and disseminate knowledge to identified audiences, and despite the fact that academics are highly motivated by this endeavor (Un et al., 2010), the form and channels by which academic research is disseminated does not support serendipitous discovery.

Table 3.

Effect of contextual elements on university-industry R&D collaboration

	Determining Factors	Influencing Factors	
Positive Effect	**ENABLERS**	**FACILITATORS**	
	Shared purpose and understanding; Complementary skills; Interest in innovation; Open minded; Realistic expectations.	Regular (face to face) interaction; Experience of working together; Long-term view; Individual preferences; Offering different perspectives; Seeking complementary approaches;	Individual Layer
	Offer space and time to think; Risk taking environment.	N/A	Organization Layer
	Key source of funding	Development of networks; Push for cross-discipline research.	External Layer
Negative Effect	**BLOCKS**	**HURDLES**	
	N/A	N/A	Individual Layer
	Conflict with other goals; Different timescales; Poor awareness of, and accessibility to, each other's work; Ways of working.	Role of legal departments; Conflicting demands on time; Interaction with other activities in the organization.	Organization Layer
	N/A	Administrative burdens; Focus on functional outcomes.	External Layer

Based on these findings, we propose five practical principles for the development of R&D projects, between universities and industry. The first principle is that organizations and individuals seeking co-creation initiatives should share information in ways that are accessible and relevant to other parties. For universities, this includes sharing research-based information through open, non-paid channels such as open access publishing; establishing a strong Internet presence; and being visible via social media channels, to enable industry to locate relevant material and expertise. Taking this steps is a practical way of building on the culture of sharing research as described by Un et al. (2010).

The second principle reflects that each organization, discipline or department may have its own terminology and ways of working. Given the implicit nature of these features, individuals may struggle to articulate or even identify them (Garfinkel, 1974). Such

difficulty is particularly likely in innovative projects (Perks et al., 2012). Project managers should encourage activities that identify these discrepancies in modes of operation and invest in establishing a common language, for instance by producing simple 'terms of reference' early in a project. Project participants need to be encouraged to 'let go' (Spiller et al., 2015, p. 13) of their discipline-specific theories and methods, and should instead embrace the opportunity to expand their perspectives and experiences.

The third principle is that third party brokers can assist in linking potential partners and in identifying research foci that benefit from integrating academic and practitioner perspectives. This principle chimes with a recommendation by Bansal et al. (2012), who argued that research collaboration should make use of intermediary organizations as facilitators or translators between industry- and university-based researchers. The profile of third party brokers could be raised by professional institutes to which many commercial organizations belong. Although the bodies we identify in this paper are UK and European Union centric, equivalent examples exist in other countries, such as the National Science Foundation in the USA.

The fourth principle is that trust is essential for the success of collaborative projects. The importance of trust in the context of co-creation has been discussed by Huikkola et al. (2013), who emphasize the need for platforms and mechanisms that support joint learning and the exploration - rather than exploitation - of resources. The development of trust should be supported by engineering small wins (Perks et al., 2012), ensuring that teams meet regularly, and giving careful consideration to the form of IP protection.

The fifth principle is that individuals are the corner stone of successful co-creation. When assembling teams it is necessary to choose individuals with a common, positive attitude towards collaboration and innovation; strong social and communication skills; and complementary technical expertise. As advised by Rese et al. (2013), smaller teams make for better interaction and information sharing. Given the value which individuals contributed to R&D collaboration, consideration is needed of how to best incentivize them to participate, whether through practical means such as the provision of sabbaticals and financial incentives, or through highlighting the symbolic and emotional benefits.

5.2. Limitations and future research directions

The insights from this research have developed what is known about the mechanisms of value co-creation in university-industry collaboration. However, a number of factors limit the study's generalizability and have implications for future research. First, the study focused on a single interdisciplinary area. Second, the participants all had some form of involvement in university-industry collaborations, which may have impacted upon their views. Third, the geographic location of the study, which was conducted within a 50-mile radius of a major university city that also contains technology spin-off businesses, may have influenced the findings. Fourth, the study did not explicitly seek nor did participants offer information about the individual benefits of participating in R&D collaborations. It is possible that the use of group interviews to gather data, may have made it socially

undesirable for participants to discuss personal benefits resulting from the commercialization of IP, such as financial gain or career advancement.

A number of future research directions are required in order to further deepen our understanding of value co-production in R&D collaborations. These directions concern the underlying conditions in which academic-industry partnerships operate, the processes which are followed, and the tensions which arise as a result. Given that opinion remains divided as to the importance of face-to-face versus remote working relationships, it would be worthwhile clarifying the origins of these views, whether this dichotomy relates to the stage in relationship formation, or if it is focused on individual preferred working practices and, thus, how these may or may not need to be changed. Furthermore, while other studies have emphasized the benefits to the individual of co-production (e.g., Rintamäki et al., 2007; Verhoef et al., 2009), our data neither supported nor contradicted this point. Further research is therefore warranted to determine the extent to which identifiable individual benefits arise from participating in these collaborations. Such evidence could be invaluable in encouraging future participation in R&D co-production initiatives, whether in digital research or in other fields. Moreover, further exploration is needed of the different tensions that are faced by university and industry partners, so that strategies can be created to manage them more effectively. For the firms, these pressures revolve around the need to solve specific business problems, such as extending a product portfolio, developing new product technologies or improving process efficiencies. From the academic perspective, tensions are associated with the drive to develop a broad-based program of research and to generate data. A consequence of these different stances may be that industry is initially

more focused on the transactional aspects of the collaborations, while universities may be satisfied with the relational benefits which the collaborations generate. This tension, the origins of which are in the differing factors which drive each group, is worthy of future investigation. A longitudinal case study approach which tracks the progress of particular collaboration could be invaluable, offering useful insights into how these tensions emerge, are managed, and play out over time.

The value of university-industry R&D collaboration extends well beyond the participating parties. As well as the production of new knowledge, there are significant societal benefits (Hartley & Benington, 2000), and the potential to accelerate the discovery process (Bramwell & Wolfe, 2008; Lee, 2000). In advancing the conceptual understanding of the mechanisms for the successful co-production of value, our paper contributes both theoretically and practically to the debate.

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