Recipes for success: Conditions for knowledge transfer across open innovation ecosystems

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Abstract: Open innovation ecosystems involve the transfer of knowledge between multiple stakeholders to contribute toward product and service innovation, and to an extent, have superseded network-level approaches to co-creation. Effective management of the knowledge and information transferred between ecosystem partners is crucial for the process of open innovation. However, to date, limited research has focused on ascertaining the conditions required for knowledge transfer success, particularly where the context involves collaboration between diverse organizational actors. Correspondingly, this study extends existing knowledge by presenting an exploration of conditions for knowledge transfer success between ecosystem partners. Semi-structured interviews were conducted with thirty key stakeholders in order to acquire their perceptions of the presence of specific conditions within their ecosystem partnerships. Empirical data were analyzed using a fuzzy-set Qualitative Comparative Analysis approach, resulting in the production of success recipes from multinational, small and medium-sized enterprise, and academic institution perspectives. Results indicate that combinations of knowledge, relationship, and organizational characteristics contribute to knowledge transfer success. However, these combinations are found to be dependent on the type of ecosystem partnership involved. Theoretical and practical implications of the study are presented, along with acknowledged limitations and suggestions for further work.

Keywords: Knowledge transfer; ecosystem; co-creation; open innovation; fsQCA.

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1. Introduction

Knowledge is recognized as being a critical resource in today's economy, with effective inter- and intra-organizational knowledge management practices generally grounded upon well-organized knowledge sharing activities (Barão, de Vasconcelos, Rocha, & Pereira, 2017). Organizations are consequently increasingly turning toward external partnerships to acquire information (Thornhill, 2018), and in facilitating the exchange of such external knowledge, the open innovation paradigm is progressively replacing traditional innovation processes focused upon in-silo ideation, with organizations instead, sharing knowledge across organizational boundaries (Chesbrough, 2003). Open innovation ecosystems involve a multitude of actors exchanging information for co-creation (Radziwon & Bogers, 2018), generally comprising a '*pluralism of a diversity of agents […] universities, small and medium-sized enterprises, and major corporations*' (Carayannis & Campbell, 2009).

Ecosystems are at the core of open innovation activities (Bogers, Chesbrough & Moedas, 2018), making the domain a crucial area of research, and while recent years have seen the emergence of increasing levels of research activity and understanding focusing upon the network-level process of knowledge sharing, the domain continues to warrant further exploration (Randhawa, Wilden, & Hohberger, 2016). Although some research (Hamer, 2010; Meng, Li & Rong, 2019; Miller, McAdam, Moffett, Alexander, & Puthusserry, 2016; Secundo, Toma, Schiuma & Passiante, 2019) proposes frameworks for knowledge transfer, their collective limitations are threefold: (1) they fail to compare the distinctions between diverse actors within the ecosystem; (2) they exclude an empirical exploration of knowledge transfer *success;* and (3) they fail to ascertain factor inter-relations.

In light of these research gaps, this study makes the following contributions. Firstly, as argued by St-Pierre, Foleu, Abdulnour, Nomo, and Fouda (2015), ecosystem approaches should be developed in line with the needs of each firm type, given the diversity of stakeholders. Consequently, and aligned with the view of St-Pierre et al., (2015), this research is conducted from the perspectives of different organizational actors. Secondly, a potential explanation for the high failure rate of innovation partnerships may be the absence of a holistic view of knowledge transfer (Milagres & Bucharth, 2019), necessitating a deconstruction of how information is exchanged successfully within the ecosystem context. In this light, this study investigates the various constituents of knowledge transfer success. Finally, while the extant literature identifies factors for knowledge transfer within ecosystems, it generally fails to ascertain their inter-relationships: recent calls for research (Milagres & Bucharth, 2019) have emphasized the requirement to empirically examine factor interdependencies, in order to generate a more nuanced comprehension. In order to address this gap in understanding, this research employs fuzzy-set Qualitative Comparative Analysis (fsQCA) to examine how transfer conditions combine into causal recipes.

Against this backdrop, and alongside calls by authors including Bogers et al., (2017), Milagres and Bucharth (2019) and Randhawa et al., (2016), the aim of the research presented in this paper is to make both theoretical and managerial contributions in terms of providing greater understanding of the various conditions required for knowledge transfer success in the context of open innovation ecosystems. Specifically, the following three research questions are addressed: (i) How does successful knowledge transfer differ according to organization

type? (ii) What conditions facilitate successful knowledge exchange within an ecosystem context? (iii) How are these conditions interrelated? Accordingly, the work utilizes fsQCA to conduct three separate analyses in order to examine and compare the perspectives of the three typical ecosystem organization types identified by Carayannis & Campbell (2009); academic institutions, small and medium-sized enterprises (SMEs), and major corporations.

The remainder of the paper is organized as follows. Section 2 provides an overview of the extant literature relating to knowledge transfer and innovation ecosystems, while Section 3 presents the conceptual framework utilized in the investigation. Section 4 provides an account of the methods employed, and Sections 5 and 6 present and discuss the results. Finally, closing observations comprising study limitations, and recommendations for additional work are presented in Section 7.

2. Existing Literature

2.1 Knowledge transfer

Knowledge transfer supports the process of open innovation, with organizations demonstrating reliance upon external sources of knowledge to achieve innovative success (West, Salter, Vanhaverbeke, & Chesbrough, 2014). Knowledge generates value and innovation when shared and utilized in the context of collaborative systems (Olaisen & Revang, 2017), with ecosystems correspondingly presenting multiple opportunities for organizations to share knowledge (Al-Emran, Mezhuyev, Kamaludin, & Shaalan, 2018). Social, cultural, and technological divides between inter-organizational partners generate further complexities with regard to successful knowledge diffusion (Roux, Rogers, Biggs, Ashton, & Sergeant, 2006) and the overall quality of interconnections within an innovation system affects the success of the transfer process (Secundo et al., 2018). Effective management of this knowledge-sharing process is therefore vital to ensure efficient knowledge exchange (Olaisen & Revang, 2017).

However, despite the evident significance of knowledge sharing in the context of information exchange systems, further research is necessary in this area (Al-Emran et al., 2018; Milagres & Bucharth, 2019). Conditions for effective knowledge sharing in an innovation context have been analyzed within organizations. For example, Maurer, Bartsch and Ebers (2011) examine the role of intra-organizational social capital on innovation performance through the knowledge transfer process within production projects. Rhodes, Hung, Lok, Ya-Hui Lien, and Wu (2008) investigate the role of information technology systems, trust culture, organizational structure, and learning strategy as factors affecting knowledge transfer within Taiwanese companies across high-tech industries, and find that all factors possess a positive correlation with this outcome. Tsai (2001) find a positive association between network position and absorptive capacity as facilitators of knowledge transfer in improving MNEs business performance. Examination of knowledge transfer antecedents has further been conducted within inter-organizational contexts. Hartley and Benington (2006) identify the nature of knowledge, differences in organizational interests, trust, and curiosity and respect for diversity as conditions for successful knowledge sharing between public service organizations, while Lin and Lee (2006) analyze the role of organizational climate and IT support in affecting the intention of an organization to encourage knowledge sharing between large Taiwanese companies. In the context of open innovation communities, Pirkkalainen, Pawlowski, Bick, and Tannhäuser (2018) investigate the role of psychological ownership on knowledge exchange intentions. Whilst the body of literature surrounding inter-organizational knowledge transfer is well developed and diverse in its

examination of various factors on the knowledge transfer process, limited research to date focuses on knowledge transfer success within innovation ecosystems.

2.2 Innovation Ecosystems

Existing research has directed considerable attention towards the collaboration of a network of actors who share information for the purposes of developing innovations (de Vasconcelos Gomes, Facin, Salerno, & Ikenami, 2018). Open innovation ecosystems have been explored from a variety of perspectives, including geographically proximate ecosystems (Almirall, Lee, & Majchrzak, 2014; Scozzi, Bellantuono, & Pontrandolfo, 2017) and value creation and capture (Adner & Kapoor, 2010; Ritala, Agouridas, Assimakopoulos, & Gies, 2013; Van der Borgh, Cloodt, & Roome, 2012). Creating ecosystems of diverse organizational actors coming together specifically for this purpose facilitates open innovation activity. Extant research has explored ecosystem engagement from the perspective of the three main partner typologies: multinationals, SMEs, and universities (Carayannis & Campbell, 2009).

Rohrbeck, Hölzle and Gemünden (2009) demonstrate how a multinational organization primarily utilises its open innovation ecosystem for the purpose of outsourcing new knowledge for the research and development phase of the innovation process. Much of existing research explores open innovation ecosystems from the perspectives of small businesses. Chesbrough, Kim and Agogino (2014) utilise a case study methodology to explore how a small firm engaged in the open innovation ecosystem approach in order to grow their business. Radziwon, Bogers and Bilberg (2017) illuminate the challenges of being a small and medium-sized enterprise within an innovation ecosystem; often, strong collaborative ties with ecosystem members facilitate organization and management of open innovation for SMEs. In addition, further research has identified the contributions of SMEs to the ecosystem whilst highlighting the merits and limitations of ecosystem engagement for SMEs (Radziwon & Bogers, 2018). The size of small-to-medium sized enterprises results in a more close-knit interrelation with the ecosystem: further scholars have argued that the characteristics of the lead entrepreneur within the SME affect the development and progress of its ecosystem (Pop, Roijakkers, Rus, & Hins, 2018). Moreover, St-Pierre, Foleu, Abdulnour, Nomo, and Fouda (2015) find that SME ecosystems are directly affected by their regional environments. Thus, research focusing on SME ecosystem engagement emphasises that ecosystem success is mediated by individual, organizational, and contextual factors.

Aside from organizational perspectives, further studies have assessed the ecosystem approach from university-industry perspectives. Brito (2018) implement a case-study approach to examine how universities can actually adopt a central role within an innovation ecosystem, acting as leaders and integrators. Meng, Li and Rong (2019) offer an alternative perspective through studying how ecosystems benefit universities in the context of industry-university partnerships. However, whilst these studies offer valuable insights into the role of university actors within the ecosystem, they fail to consider the role of knowledge transfer. Miller et al. (2016) adopt an absorptive-capacity lens to investigate factors affecting knowledge transfer across a quadruple helix ecosystem, discovering that such factors affect both the effectiveness and ability of stakeholders to engage in knowledge transfer. However, the authors fail to conduct comparisons between the diverse ecosystem stakeholders in terms of whether such diversity affects knowledge transfer factors.

Extant literature has thus explored how different organizational types adapt and respond to the implementation of an ecosystem approach. However, research that examines the differences between these organizational types within a single study remains absent from the existing body of knowledge. Despite the prominent role of knowledge transfer in an ecosystem context (Olaisen & Revang, 2017) limited research analyzes knowledge transfer from the perspectives of the three main organizational types at an ecosystem-level. Research focuses specifically on healthcare ecosystems (Hamer, 2010; Secundo et al., 2019) or partnerships between academia and industry (Meng et al., 2019; Miller et al., 2016). These frameworks thus fail to consider factor interrelations, multi-industry ecosystems, and differences between diverse stakeholders.

3. Conceptual Framework

Given that there is no established philosophy or model commonly accepted as providing a theoretical core for studies examining inter-organizational knowledge transfer, conditions viewed as being of fundamental importance in the process were identified via a review of the extant literature. During this process, 64 articles were reviewed, with any condition identified by more than ten of these articles as being important to the knowledge-transfer process being selected as suitable for inclusion in this study, and hence further exploration. The resulting conditions were subsequently grouped according to general characteristics, in terms of being knowledge, relationship, or organization related.

3.1 Knowledge Characteristics

Prior research has indicated that knowledge characteristics can impact upon the knowledge transfer process. Knowledge is commonly segregated into two categories – tacit and explicit. Tacit knowledge is more personal and experiential, residing within the individual mind (Nonaka, 1994). It presents far greater transfer difficulties than its counterpart, explicit knowledge, as the latter involves more codifiable formalized information (Narteh, 2008). Thus, knowledge type represents the first knowledge-related characteristic. In relation to this, difficulties surrounding the articulation of knowledge present a further barrier to the transfer process. Translation processes surrounding the exchange of tacit knowledge can decelerate its transfer (Al-Salti & Hackney, 2011). Thus, a thorough understanding of the knowledge received is argued to expedite the transfer process further.

A further component of knowledge understanding is causal ambiguity. Causal ambiguity refers to a lack of clarity surrounding the underlying origins and components of knowledge (Powell, Lovallo, & Caringal, 2006). Knowledge that has low causal ambiguity will subsequently be easier to transfer as it requires less explanation (Al-Salti & Hackney, 2011). Type & Understanding of Knowledge, and Causal Ambiguity therefore represent knowledge characteristics which arguably influence the level of knowledge transfer success.

3.2 Relationship Characteristics

Characteristics surrounding the ecosystem relationship further facilitate and underpin knowledge transfer. The most commonly cited factor, trust, has been defined as being the confident expectation that a partner will be a reliable source of information and will meet their obligations as a transferee of knowledge (Inkpen, 1998). Trust stimulates organizations to collaborate and share knowledge (Inkpen & Tsang, 2005): thus, it is expected that high levels of trust will engender a successful knowledge transfer process. Trust additionally strengthens a partnership (Narteh, 2008) which leads to the second relationship characteristic: strong ties between organizations. Strong ties

encourage frequent knowledge exchange (Cummings & Teng, 2003; Xie et al., 2016) and it is thus suggested that a strong tie will safeguard successful transfer. Trust and tie strength thus represent the key relationship-related characteristics found to influence knowledge transfer.

3.3 Organizational Characteristics

Conditions relating to the recipient organizations are of further significance for successful knowledge transfer. Cultural similarity between organizations has been cited as expediting knowledge transfer (Cummings & Teng, 2003), as dissimilarities can present misunderstandings which delay the transfer process (Van Wijk, Lyles & Salk, 2008). Cultural congruencies are expected to encourage transfer.

Furthermore, organizational motivation to learn from a partner organization has been found to boost successful knowledge sharing, and as such, learning intent involves an organizational desire, determination, and will to learn from a partner (Simonin, 2004). Knowledge transfer is increased when this objective is instilled (Inkpen, 1998). In relation to this, the ability of the recipient organization to acquire and utilize the newfound knowledge is a further organizational characteristic which determines the success rate of the transfer process. Referred to as absorptive capacity, organizations need to possess the capabilities to recognize knowledge value, diffuse it internally, and apply it to beneficial ends (Cohen & Levinthal, 1990). The presence of such capabilities has been found to expedite the transfer process (Van Wijk et al., 2008). Cultural similarity, learning intent, and absorptive capacity thus represent the organizational characteristics identified within the extant literature as advancing knowledge transfer.

3.4 Combinations of Conditions

Within the extant literature, some scholars examine the influence of single conditions on knowledge transfer (e.g., Abrams, Cross, Lesser, & Levin, 2003; Ambos & Ambos, 2009; Minbaeva & Michailova, 2004; Simonin, 1999), whilst others investigate the influence of multiple conditions (e.g., Lawson & Potter, 2012; Miller et al., 2016). Whilst previous studies have applied fsQCA to the analysis of organizational (Cobo-Benita, Rodríguez-Segura, Ortiz-Marcos, & Ballesteros-Sánchez, 2016; Fiss, 2007; Mikalef, Boura, Lekakos, & Krogstie, 2019; Mikalef, Pateli, Batenburg, & Wetering, 2015) knowledge (Hughes, Cesinger, Cheng, Schuessler, & Kraus, 2017) and relationship (Karatzas, Johnson, & Bastl, 2016; Zaefarian, Thiesbrummel, Henneberg, & Naudé, 2017) characteristics, limited research has incorporated these factor types to the configurational analysis of knowledge transfer success. Despite a number of reviews (Al-Salti & Hackney, 2011; Cummings & Teng, 2003; Van Wijk et al., 2008), consensus surrounding key constituents of inter-organizational knowledge transfer, and their interrelations, remains absent. The large number of conditions cited within existing research, and inconsistencies between their combined versus singular effects, strongly indicates that no single condition attains overall responsibility for knowledge transfer success. Thus, there may be many ways to achieve this outcome, grounded upon equally contributing combinations of causal conditions (Pappas et al., 2016): this notion is termed equifinality, an underlying tenet of fsQCA. It is expected therefore that multiple causal recipes can result in successful knowledge transfer.

Causal asymmetry encompasses a further foundation of fsQCA, whereby conditions leading to the presence of the outcome differ from those leading to its absence (Fiss, 2011). Therefore, while there may be many configurations leading to the presence of success, these may not be causally symmetrical when examining its absence, and combinations of conditions may be necessary or sufficient for this outcome. According to Woodside

(2014), no single factor is likely to be sufficient or necessary when analysing the complex phenomenon of success, and research that focuses solely on examining the presence of success is unlikely to shed light on the causes of failure. Akin to Woodside's (2014) research, the literature formulating the conceptual framework for this investigation indicates that the seven single conditions consistently associate with success and not with failure. Moreover, research suggests that specific conditions can enable or inhibit knowledge transfer, depending on the presence or absence of other conditions (Simonin, 2004; Squire, Cousins, & Brown, 2005). Conditions were consequently expected to contribute to both the presence and absence of success.

Figure 1 presents the conceptual framework formed by the proposed integration of the conditions identified in this work as being significant. As existing research proposes multiple descriptions of knowledge transfer success, with no generally accepted definition, this study views successful knowledge transfer as being the *active exchange of knowledge between organizations, involving measurable and effective knowledge absorption, application and satisfaction by the recipient organization*.

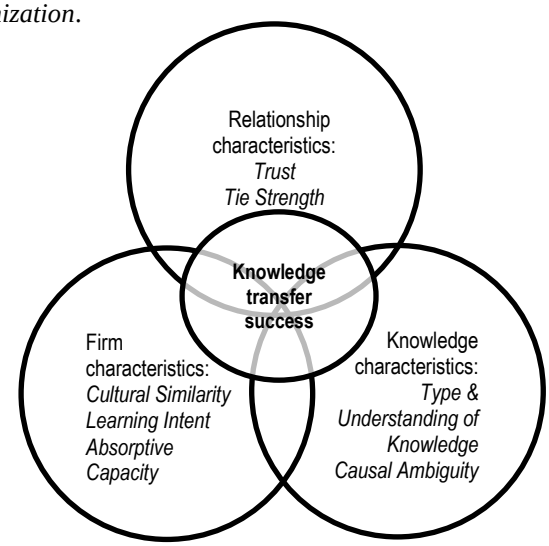

Fig. 1. Conceptual Framework

4. Research Methodology

4.1 fsQCA

FsQCA is an analytical technique that enables the identification of patterns of elements that lead to a given outcome (Pappas, Kourouthanassis, Giannakos, & Chrissikopoulos, 2016). This research necessitated an analysis that would holistically examine each case in-depth, permitting a cross-comparison of the variances between ecosystem member perspectives of the conditions, while illuminating the combinatory nature of the transfer conditions. FsQCA achieves these objectives through combining the in-depth case familiarity associated with qualitative analysis, and the cross-case comparison typically fostered by quantitative research, with cases being viewed holistically as complex configurations of causal conditions (Greckhamer, Misangyi, Elms, & Lacey, 2008). FsQCA indicates that causation cannot be easily unraveled, because (1) outcomes rarely possess a single cause, (2) causes can rarely be isolated, and (3) causal conditions can exert distinct and opposing effects, dependent upon the context (Greckhamer et al., 2008). The complexity of knowledge transfer success warranted

an analysis that would explore the nuances of the conditions; hence, the aim was not to reveal causation, but to gain better insights into the outcome.

This study splits the analysis across three separate categories corresponding to the three organization types, each category comprising ten cases. While it is acknowledged that this is a small sample, the analysis of small-n situations has been identified as a key strength of the fsQCA method (Kraus et al., 2018), the use of this number of cases being widely accepted across fsQCA research. Small-n situations have been classified as between 10 and 50 cases (Fiss, 2007; Greckhamer, Misangyi, & Fiss, 2013; Kraus et al., 2018; Ragin, 2008). Furthermore, Legewie (2013) identifies ten cases as being the minimum threshold for applying the fsQCA method. However, Greckhamer et al. (2013) state that sample sizes of ten depend on substantial in-depth cross case and within-case analyses in order to systematically compare causal configurations across cases. To alleviate this potential issue, this research utilises qualitative data to conduct more in-depth analyses into each ecosystem case.

In light of these requirements, fsQCA was selected as the appropriate analytical approach. Studies investigating multiple causal conditions typically utilise regression-based techniques (Becerra, Lunnan & Huemer, 2008; Chen, 2004; Lee, 2001; Santoro & Bierly, 2006) thus neglecting the interdependencies and complex causal relations between these conditions (Woodside, 2014) which can only be achieved through a configurational approach (Pappas, 2018). Thus, as stated by Fiss (2011), fsQCA demonstrates the greatest level of suitability for explaining the interconnected nature of causal conditions, and how they can combine into multiple causal recipes. FsQCA has been previously employed to investigate knowledge-transfer (Oyemomi, Liu, Neaga, Chen & Nakpodia, 2019; Xie, Fang & Zeng 2016) and success factors (Mozas-Moral, Bernal-Jurado, Medina-Viruel, & Fernández-Uclés, 2016), evidencing its suitability for realizing the objectives of this research. While the level of use of fsQCA is increasing in general within innovation research (Kraus, Ribeiro-Soriano, & Schussler, 2018), its ability to provide cross-case comparisons against a given outcome (in this case, knowledge transfer success), and general lack of research involving its application to open innovation ecosystems, further justify its usage.

4.2 Procedure and Subjects

Within open innovation ecosystems, some organizations will operate as a keystone (Radziwon & Bogers, 2018) adopting a centralized position due to its many connections and ability to enrich the ecosystem. In this study, a multinational services provider operating as the keystone of its innovation ecosystems acted as the empirical focus for the investigation. A number of innovation ecosystems of the keystone organization were examined in order to facilitate greater sample diversity. Not all ecosystem partners of the keystone organization were invited to participate due to logistical constraints, as well as new partnerships being continuously created due to the nature and scale of the multinational corporation in question.

Partners within the ecosystems were located across various industries, including technology, telecommunications, education, software, and transport. Participants were chosen due to their experience of collaborating within an innovation ecosystem. Purposive sampling was employed to identify potential participants. This resulted in 30 ecosystem members – ten representatives from each organizational category. The multinational category comprised of ten participants, four from the technology industry, one from transport, three from services, and two from telecommunications. For the small business category, industries included two from software, two from financial, and six from technology. Interviewees from academic institutions were all located

within the education sector. In summary, ten technology companies, two software, one transport, three services, two telecommunications, two financial companies, and ten academic institutions formulated the sample. Further information regarding the roles and innovative activities of the participants is displayed in Table 1.

Table 1. Participant Information

Organization Type	**Industry (n)**	**Main Innovation Activities**	**Organizational position (n)**
Multinational	Technology (4)	Software developments	Department Head (2), Manager (2)
	Transport (1)	Assistive technologies	Department Head (1)
	Services (3)	Software developments, service solutions	Department Head (2) Chief Technology Officer (1)
	Telecommunications (2)	Software developments	Manager (1), Chief Technology Officer (1)
Small-to-medium sized Enterprise	Software (2)	Assistive technologies, software developments	Department Head (1), Director (1)
	Financial (2)	Assistive technologies, software developments	Director (1), Department Head (1)
	Technology (6)	Assistive technologies, hardware developments	Director (2), Manager (3) Department Head (1)
Academic Institution	Education	Technology and idea translations, urban developments, hardware developments, health and service technologies	Manager (3), Department Head (3), Professor (2), Director (2)

Ecosystem members were invited to participate in a semi-structured telephone interview in order to capture their perceptions of the various key conditions within their open innovation ecosystem. Questions within the interview schedule were directly related to the seven conditions previously identified within the knowledge transfer literature. A seven-point scale applying the principles of the semantic differential approach was used in each case to assess the perceived level of presence of each condition. Opposing adjectives were placed at either end of the scale to reflect the perception of absence and presence of the condition. In each case, for each condition, the scale measure was supplemented with additional questions that guided an unstructured section of the interview (Table 2) in order that participants provided further insights into the rationale behind their scale ratings.

The usage of single-item scales is widely accepted within fsQCA research (Muñoz & Kibler, 2016; Pappas, Mikalef, Giannakos, & Pavlou, 2017; Schmitt, Grawe, & Woodside, 2017) and although not as common, single-item semantic differential scales are also employed (Seate, Joyce, Harwood, & Arroyo, 2015). However, critics have argued that such scales are not supported by evidence of validity or reliability (Al-Hindawe, 1996). Thus, Al-Hindawe (1996) argues that semantic differential scales should be accompanied by interviews, as observed in Klemmack & Ballweg's (1973) research, to further confirm the results of the scale ratings with participants. The usage of these scales within the interviews afforded the imposition of a numerical assessment of the presence of each condition. Due to the subjective nature of the conditions, assessing the extent of their presence within the partnerships would have been difficult to achieve through solely qualitative assessments. However, the

exploratory nature of this study necessitated qualitatively oriented questions that would encapsulate further details and opinions from respondents regarding each of the conditions. Thus, the single-item scales were accompanied with further qualitative questions to afford a more holistic and detailed understanding of the conditions.

Table 2. Interview Questions

Condition	**Initial Questions & Semantic Differentials**	**Follow-up Questions** (for each condition, based on response to initial question)
Type & Understanding of Knowledge	Would you say the knowledge you gained from your ecosystem partner was information highly personal and experiential, specific to your ecosystem partner (tacit)? Or was it more technical knowledge, in the form of perhaps manuals or policies (explicit)?	Could you please tell me a bit more about why that is? Why didn't you choose a lower/higher rating? Can you give me an example of this? I'd like to hear more about…
	Please rate your level of understanding of the information you received, ranging from low level to high level.	
Low Causal Ambiguity	To what extent do you believe that the origins of the information gained from your ecosystem partner were unambiguous, ranging from unclear to clear?	
Trust	To what extent do you believe that you have a trustworthy relationship with your ecosystem partner, ranging from untrustworthy to trustworthy?	
Tie Strength	To what extent do you believe that you have a strong relationship with your ecosystem partner, ranging from weak to strong?	
Cultural Similarity	To what extent do you believe that your organization possesses an organizational culture similar to that of your ecosystem partner, ranging from dissimilar to similar?	
Learning Intent	To what extent do you believe that your organization possesses a willingness to learn new knowledge, ranging from unwilling to willing?	
Absorptive Capacity	To what extent do you believe that your organization absorbs and acquires new knowledge, ranging from un-absorptive to absorptive?	

In order to determine whether the ecosystem relationships could be categorized as instances of a successful knowledge transfer process, the previously presented definition of knowledge transfer success was assessed via both the Likert-scale measurements/semantic differential statements, along with data acquired from the 30 semi-structured interviews. Data for each case was converted into a transcript containing both the scale ratings and transcribed qualitative data obtained from the additional questions. These transcripts were then adjusted through the calibration process to possess the correct format for fsQCA.

4.3 Calibration and Truth Table

FsQCA operates on the basis of cases demonstrating degrees of membership within a set; this is achieved through calibrating the data into values between 0 and 1. The original measures from the semantic differential scales required conversion in order to reflect the extent to which each ecosystem partnership, based upon participant perceptions, could be considered as possessing membership within each condition: thus, qualitative anchors within the scales were used to calibrate the conditions (see Ordanini, Parasuraman & Rubera, 2014). The calibration procedure requires specification regarding threshold values as boundaries for full membership within

the outcome, full non-membership, and the maximum level of ambiguity (Fiss, 2011). Natural breakpoints within the semantic differential scales were used as the three threshold values. The value for full membership was fixed at 6; the crossover point was set at 4.5, and full non-membership was fixed at 3. The use of natural scale breakpoints is an accepted approach for calibrating fuzzy sets (Ordanini et al., 2014; Pappas et al., 2016; Woodside, 2013) in that substantive knowledge of the cases drives the calibration of conditions, rather than sample means (Oyemomi et al., 2019).

Following the calibration procedure, a truth table is produced, requiring refinement according to frequency and consistency. Frequency refers to the number of empirical observations of cases containing each combination of conditions: within a small data set, an acceptable frequency cut off can be set at 1 (Ragin, 2009). According to Ragin, consistency assesses the degree to which the causal combinations represent a subset of the outcome, with the minimum acceptable consistency threshold for any solution recommended as being 0.75. Cases with a frequency value of less than one and consistency values of less than 0.8 were removed from the truth table.

5. Results

The presence of the causal conditions for successful knowledge transfer was analyzed for multinationals, for SMEs, and for academic institutions. The fsQCA results present diverse solutions (or recipes) that illustrate the presence or absence of different conditions, but which ultimately lead to the same result – in this case, successful knowledge transfer within the ecosystem. According to Fiss (2011), a mix of parsimonious and intermediate solution-types are appropriate in identifying core and peripheral conditions for a given solution; conditions present within both parsimonious and intermediate solutions are referred to as core conditions, whereas those solely present within the intermediate solution are identified as peripheral conditions. Core conditions are deemed essential, whereas peripheral conditions are considered less important as they are exchangeable within other conditions.

5.1 Multinationals

Table 3 illustrates that four solutions exist for multinational-multinational collaboration. The first solution reveals the presence of Causal Ambiguity, Trust, Tie Strength, Learning Intent, and absence of Cultural Similarity as peripheral conditions, with Absorptive Capacity as a core condition, and Type & Understanding of Knowledge as an unimportant condition.

Solutions Two and Three both display the presence of Type & Understanding of Knowledge and Causal Ambiguity as being peripheral conditions, and Cultural Similarity, Absorptive Capacity and Learning Intent as core conditions. They differ on Tie Strength as being unimportant within Solution Two, and Trust as being unimportant within Solution Three. Solution Four requires the presence of Type & Understanding of Knowledge, Trust and Cultural Similarity, the absence of Learning Intent and Absorptive Capacity as peripheral conditions, and the absence of Causal Ambiguity and Tie Strength as core conditions.

The overall solution coverage indicates the extent to which knowledge transfer success can be determined based on the solutions provided. Results indicate an overall solution coverage of 0.81, which suggests that a substantial proportion of the outcome under consideration is provided by the four solutions. The overall solution consistency indicates the level of sufficiency, with the value of 0.9 being substantially above the commonly

accepted threshold of 0.75 suggested by Ragin (2008). Raw coverage for single solutions ranges from 0.51 to 0.14, with corresponding consistency ranging from 0.93 to 0.82, indicating that all solutions surpass the required threshold.

Table 3. Solutions for Multinationals

	Solution			
Configuration	1	2	3	4
Type & Understanding of Knowledge		●	●	●
Causal Ambiguity	●	●	●	⊗
Trust	●	●		●
Tie Strength	●		●	⊗
Cultural Similarity	⊗	●	●	●
Learning Intent	●	●	●	⊗
Absorptive Capacity of recipient firm	●	●	●	⊗
Consistency	0.93	0.92	0.92	0.82
Raw Coverage	0.51	0.40	0.40	0.14
Unique Coverage	0.28	0.12	0.13	0.06
Overall solution coverage	0.81			
Overall solution consistency	0.90			

Black circles (●) indicate the presence of a condition, crossed out circles (⊗) indicate its absence. Large circles represent core conditions, small circles represent peripheral conditions; blank spaces indicate unimportant conditions.

5.2. SMEs

The four solutions obtained for SMEs are presented in Table 4. The first solution indicates that Causal Ambiguity, Trust and Tie Strength are peripheral conditions; Type & Understanding of Knowledge, Learning Intent and Absorptive Capacity are core conditions; and Cultural Similarity is unimportant for knowledge transfer success. The second solution contains the same core and peripheral conditions as Solution 1, except that Causal Ambiguity is irrelevant for knowledge transfer success. It can thus be assumed that Causal Ambiguity and Cultural Similarity are substitutable across the first two solutions.

The third solution reveals the presence of Type & Understanding of Knowledge and Tie Strength, and the absence of Cultural Similarity, Learning Intent, and Absorptive Capacity, as core conditions: and Causal Ambiguity and Trust as peripheral conditions. Solution 4 presents Type & Understanding of Knowledge, Learning Intent and Absorptive Capacity as core conditions, and the presence of Cultural Similarity as a peripheral condition; the absence of Causal Ambiguity, Trust, and Tie Strength are also peripheral. As Type & Understanding of Knowledge was core across all solutions, this condition was a likely candidate for a necessary condition. However, this condition did not meet the recommended 0.9 threshold within the Necessary Conditions Analysis: with a consistency score of 0.86, it can be concluded that this condition was not necessary in this instance.

Results indicate an overall solution coverage of 0.67, which suggests that while a substantial proportion of knowledge transfer success between multinationals and SMEs is provided by the four solutions, the outcome is not wholly explained, and other recipes for knowledge transfer success between multinational enterprises and SMEs may also exist. The overall solution consistency value of 0.98 is substantially above the 0.75 threshold. Raw coverage for single solutions ranges from 0.31 to 0.13, with corresponding consistency ranging from 1.0 to 0.95, all solutions therefore exceed the required threshold.

Table 4. Solutions for SMEs

	Solution			
Configuration	1	2	3	4
Type & Understanding of Knowledge	●	●	●	●
Causal Ambiguity	•		•	⊗
Trust	•	•	•	⊗
Tie Strength	•	•	●	⊗
Cultural Similarity		•	⊗	•
Learning Intent	●	●	⊗	●
Absorptive Capacity of recipient firm	●	●	⊗	●
Consistency	0.95	0.96	1	1
Raw Coverage	0.30	0.31	0.27	0.13
Unique Coverage	0.07	0.09	0.19	0.06
Overall solution coverage	0.67			
Overall solution consistency	0.98			

Black circles (●) indicate the presence of a condition, crossed out circles (⊗) indicate its absence. Large circles represent core conditions, small circles represent peripheral conditions; blank spaces indicate unimportant conditions.

5.3. Academic Institutions

Table 5 illustrates that two solutions exist for knowledge transfer success supporting multinational-academic institution collaboration and co-creation. The first solution reveals that presence of Type & Understanding of Knowledge, Trust, and Tie Strength are peripheral conditions. Absence of Causal Ambiguity and Absorptive Capacity are also peripheral conditions, while the absence of Cultural Similarity is a core condition for this first solution. This configuration is similar to the second solution, apart from the absence of Tie Strength being a peripheral condition, along with the presence of Causal Ambiguity and of Absorptive Capacity. These three conditions can accordingly be considered substitutable. Regardless of the presence or absence of Causal Ambiguity, Tie Strength, and Absorptive Capacity, academic institution-multinational relationships require understanding, trust, and intention to learn, along with the absence of Cultural Similarity. Usually, a condition is referred to as ‘necessary’ (but not sufficient) for a given outcome if the associated consistency value meets or exceeds the threshold of 0.9 (Ragin, 2006), and in the case of academic institution-multinational relationships,

Type & Understanding of Knowledge (0.959), Trust (0.998), Learning Intent (0.988), and lack of Cultural Similarity (0.952) all meet this criterion.

Results indicate an overall solution coverage of 0.84, which suggests that a substantial proportion of knowledge transfer success between multinationals and academic institutions is provided by the two solutions. The overall solution consistency value of 0.86 is substantially above the 0.75 threshold. Raw coverage for single solutions ranges from 0.74 to 0.25, with corresponding consistency ranging from 0.87 to 0.84, both solutions therefore exceed the required threshold.

Table 5. Solutions for Academic Institutions

	Solution	
Configuration	1	2
Type & Understanding of Knowledge	●	●
Causal Ambiguity	⊗	●
Trust	●	●
Tie Strength	●	⊗
Cultural Similarity	⊗	⊗
Learning Intent	●	●
Absorptive Capacity of recipient firm	⊗	●
Consistency	0.87	0.84
Raw Coverage	0.25	0.74
Unique Coverage	0.10	0.59
Overall solution coverage	0.84	
Overall solution consistency	0.86	

Black circles (●) indicate the presence of a condition, crossed out circles (⊗) indicate its absence. Large circles represent core conditions, small circles represent peripheral conditions; blank spaces indicate unimportant conditions.

6. Discussion

6.1 Multinationals

Solutions for the multinational category exhibit distinct core and peripheral conditions. Absorptive Capacity manifests as a core condition across three of the four solutions. This emphasizes that effective knowledge absorption is paramount for knowledge transfer success. Qualitative responses of participants demonstrate that the ability of the organization to disseminate knowledge internally was a core component of corporate strategy when engaging in an ecosystem partnership.

The absence of Tie Strength is core within Solution Four. This may be due to multinational partners exhibiting a weaker relationship due to the complexities surrounding collaboration with a potential competitor, and the uncertainty surrounding the possible loss of a deal due to the presence of another global partner within the

innovation ecosystem. This directly opposes existing literature which argues strong ties to facilitate knowledge transfer (Xie et al., 2016). Moreover, the absence of Causal Ambiguity as a core condition within Solution Four further mediates this. Multinational partners may feel discouraged from sharing the exact origins of knowledge due to coopetitive collaboration. Multinationals will often understand the information received if they are collaborating within the same sector but ample translation of the exact origins of this knowledge may often be unnecessary for knowledge transfer to occur.

The presence of Cultural Similarity as a core condition across Solutions Two and Three indicates that organizational similarity contributes to successful knowledge transfer; this is unsurprising, as multinationals will be collaborating with the keystone organization, another multinational, which is expected to possess similar cultural values and beliefs. The presence of Learning Intent as a core condition may be directly related to Cultural Similarity: existing inter-organizational literature states that an organization will be encouraged to transfer knowledge if they are collaborating with a partner who perpetuates a desire to receive (Lawson & Potter, 2012). Such a desire is arguably embedded within the norms and values of an organization, and subsequently integrates into the overall culture of an organization. Thus, possessing similar cultures can operate as an antecedent for learning intent, explicating the causal essentiality of both conditions.

Results consequently illustrate that combinations of knowledge, relationship, and organizational characteristics are of importance for successful transfer of knowledge between multinational corporations. No condition is consistently present or absent across all solutions, and there are no necessary conditions in this instance.

6.2 SMEs

When observing the Solutions for the SME category, distinct core and peripheral conditions are displayed. The presence of Learning Intent and Absorptive Capacity are core conditions across 75% of the solutions. Knowledge acquired within SME-Multinational partnerships is often niche knowledge that has driven the ecosystem relationship, due to the multinational organization retaining a requirement to source new and innovative ideas from a small business (Bougrain & Haudeville, 2002). Thus, Type & Understanding of Knowledge is a core condition because the type of knowledge obtained from the partner formulates the underlying rationale for pursuing this type of partnership. This knowledge is often solely sought by one division of a large multinational corporation responsible for maintaining the ecosystem relationship, and therefore this knowledge is not acquired and obtained throughout the organization as a whole. This may explain the absence of Learning Intent and Absorptive Capacity within Solutions One, Two and Four.

In addition, the absence of Cultural Similarity as a core condition can be explained by excessive organizational similarities generating a clash. SMEs typically operate differently to multinationals, retaining greater agility and speed of working pace. As indicated by one participant, they '*bring something new to the table*' - thus offering different ways of working. These inconsistencies between working practices may indicate that collaboration between culturally diverse organizations is beneficial for successful knowledge transfer. This contrasts existing research – see for instance Cummings & Teng, (2003) and Narteh, (2008) - which argues that cultural similarity is an antecedent of knowledge transfer success.

The four solutions subsequently highlight Learning Intent and Absorptive Capacity as core conditions, except in the instance where Cultural Similarity is absent, where the absence of these conditions is core. Organizations may be reluctant to absorb the new knowledge due to inconsistencies between values and beliefs. It may be the case that intent to learn from an ecosystem partnership mediates an alteration of internal structures and mechanisms in order to embrace that new knowledge. The absence of Learning Intent, Absorptive Capacity, and Cultural Similarity as core conditions may further derive from the presence of Tie Strength as a core condition within Solution Three: a stronger relationship may mediate the impact of the absence of these conditions. However, as these conditions are interchangeable across the solutions, it is evident that other core conditions, such as Type & Understanding of Knowledge, are of greater significance for knowledge transfer success.

6.3 Academic Institutions

Finally, solutions for academic institutions reveal that the absence of Cultural Similarity is the sole core condition across the two solutions. This indicates in this context that a level of diversity between organizations is beneficial for knowledge transfer success. Organizational diversity in terms of values and beliefs reflects the objectives of an organization. Academic institution objectives are fundamentally research and teaching; whereas the keystone organization employed a more revenue-driven objective. This generates a lack of competition, moderated by organizational heterogeneity, and is clearly significant for successful knowledge transfer between industry and academia – hence its presence as a core (and necessary) condition within these solutions.

The presence of Learning Intent as a necessary condition for successful knowledge transfer may be grounded upon the principle that academic-industry collaboration is often pursued on the basis of addressing a specific knowledge gap (Nieto & Santamaria, 2007) and thus, the aim is to learn new knowledge from that institution. However, recipient organizations have to possess an intention to learn in order to achieve this objective and effectively co-create.

The existence of Trust as a necessary condition may be due to academic institutions and multinationals operating within entirely different sectors, displaying diverse visions and organizational objectives which may engender a sense of unfamiliarity and discord between customary practices. The heterogeneity of academic procedures may require a higher level of trust simply because they are not accustomed to the former's way of working. Conversely, academic institutions need to be confident that partner organizations will not exploit the relationship, or the new knowledge acquired. This confirms the findings of existing research substantiating the viability of trust for expediting the transfer process (Inkpen & Tsang, 2005). Type & Understanding manifesting as a necessary condition within the solutions may relate to the presence of trust as operational differences may require a greater understanding of the transferred knowledge. The highly specific nature of this knowledge – whether tacit or explicit - further implies the significance of its understanding by the recipient organization.

As four conditions were necessary for academic institutions, they can be deemed vital for knowledge transfer success, as without their configurational presence, the outcome would not occur. Hence, whilst they are necessary as single conditions, their configurational presence in the solutions is of greater significance.

6.4 Responses to Research Questions

This research subsequently exposes the heterogeneity of the knowledge transfer process according to different organizational sources. Responses to the research questions underpinning this study are provided as follows.

(i) *How does successful knowledge transfer differ according to organization type?* This research utilised fsQCA to ascertain the causal configurations for knowledge transfer success for multinationals, SMEs, and academic institutions operating within an innovation ecosystem. Results emphasise that these distinct organizational typologies depend upon different combinations of knowledge, firm, and relationship related characteristics. Each organizational category exhibits distinct core and peripheral conditions, indicating that transfer success is underpinned by diverse causal recipes.

(ii) *What conditions facilitate successful knowledge exchange within an ecosystem context?* To ascertain inter-organizational antecedents of transfer success, this research developed a conceptual framework that detailed knowledge, firm and relationship characteristics. Such characteristics were expected to combine and overlap in the context of innovation ecosystems. Results identify that the presence or absence of the conditions contribute to success, depending upon the combinations of conditions within causal configurations. Although the conditions possessed varying significance in terms of their necessity and core or peripheral nature, ultimately it is their contribution to a configuration that leads to success.

(iii) *How are these conditions interrelated?* In addition to being among the few studies to adopt the multinational-ecosystem perspective, this research is also the first to examine conditions of knowledge transfer success and their interconnections through employing fsQCA as the analytical technique. This permitted a cross-case analysis of causal recipes for success in the context of multinational enterprises and their innovation ecosystem, revealing how the transfer conditions possessed unique integrations with their counterparts, and retained varying levels of co-dependency and prominence for the outcome. The groupings of characteristics are also related, as no single grouping retains overall necessity or sufficiency: in confirmation of the pictorial representation of the conceptual framework, the characteristics interrelate in order to achieve success.

6.5 Theoretical Contributions and Implications

This study provides a number of theoretical implications for the field of research surrounding open innovation ecosystems. Findings confirm that similar groupings of factors (organizational, knowledge, and network) as analyzed in Miller et al. (2016) are significant for knowledge transfer within stakeholder partnerships across academia and industry. Whilst previous studies have investigated the influence of single (e.g., Abrams, Cross, Lesser, & Levin, 2003; Ambos & Ambos, 2009; Minbaeva & Michailova, 2004; Simonin, 1999) versus multiple conditions (e.g. Lawson & Potter, 2012; Miller et al., 2016), this study organizes transfer constituents into three predominant groupings. Results from fsQCA indicate that the condition groupings are highly interrelated, with no characteristic demonstrating overall prominence. Research examining knowledge transfer within an ecosystem context should consider the pertinence of these groupings.

Moreover, this research offers a progression of previous knowledge transfer models for innovation ecosystems. The proposed framework for knowledge transfer success is conceptually generated and empirically validated. Secundo et al. (2019) and Hamer (2010) produce classification frameworks for ecosystems within the healthcare sector but fail to empirically determine and validate enablers of knowledge transfer between the various stakeholders. This limitation is further observed in Meng et al.'s (2019) work. Miller et al. (2016) effectively identify such enablers but examine their application solely to university-industry partnerships. This study has

subsequently addressed this limitation by analyzing knowledge transfer success between diverse ecosystem stakeholders using an original conceptual model.

6.6 Managerial Contributions and Implications

Results of the study presented in this paper have several significant implications for organizations electing to pursue an ecosystem approach to open innovation, particularly for multinational enterprises that possess centralized positions within their ecosystems. For multinationals, knowledge transfer success could be facilitated through the presence of cultural similarity: multinational partners could co-organize events that would present opportunities to share cultural norms and values. This could in turn increase similarities between organizations whilst educating attendees on the cultures of their partners. Additionally, knowledge transfer for both small businesses and multinational corporations retains high dependence on learning intent. Policies should thus be implemented that incorporate learning intent as an integral component of an organization's business strategy. Introducing learning intent as an organizational objective could thus facilitate both inter- and intra-organizational knowledge transfer. Finally, absence of cultural similarity operates as an enabler of knowledge exchange for academic institutions, reinforcing that organizational efforts need to be directed toward the maintenance of this diversity, sustaining existing processes, systems, and behaviors that contribute to the overall organizational culture. Additionally, the necessity of learning intent, trust, and understanding within the academic category emphasizes the significance of cultivating these attributes. Workshops between industry and academia could generate and maintain alignment in order to ensure that specific knowledge requirements are addressed, fostering greater learning intent and understanding within the recipient industry partner while instilling trust due to increased interaction and greater transparency surrounding partner objectives and strategies.

Despite individual core conditions retaining necessity across the different partner typologies, no single group of conditions is necessary across all organizational perspectives, with a range of combinations of knowledge, relationship, and organizational conditions being important for successful knowledge transfer. Hence, while the knowledge transfer process within and across ecosystem relationships can be facilitated via the presence of individual necessary conditions, it is essential for organizations to be aware of the need to achieve a significant presence of all seven conditions. This emphasizes that there is no consistent, universal approach to successful knowledge transfer within open innovation ecosystems; both conditions and partnership typologies engender diversity across transfer practices. Organizational awareness, ambition, and commitment toward inducing the presence of these conditions as well as an understanding of the partnership typology are therefore recommended and encouraged.

7. Conclusions

This research presented an investigation of the conditions facilitating knowledge transfer success across open innovation ecosystems. The heterogeneity of organizational actors collaborating within open innovation ecosystems necessitated exploration of whether conditions of knowledge transfer success varied between ecosystem partnerships. The analytical technique of fsQCA permitted observation of how the seven conditions integrate into a number of causal recipes for knowledge transfer success. The original conceptual model demonstrated that a combination of knowledge, relationship, and organizational characteristics would contribute to the successful transfer of knowledge between members of an open innovation ecosystem. No single group of characteristics was necessary or sufficient for producing the outcome; therefore, it can be ascertained that

combinations of these categorizations are essential for successful knowledge transfer. Organizations should, therefore, attempt to integrate them into their repertoires when exchanging knowledge across open innovation ecosystems.

A number of limitations of the study are acknowledged, which may be addressed through further activity. The sample size is relatively small and is drawn from a single ecosystem. Hence, further research should attempt to analyze a larger number of ecosystem partners across multiple ecosystems. Despite ecosystem partners engaging in innovation relationships across Europe and the US, research in this domain could be expanded to encompass ecosystems within a greater variety of both global and local contexts. In addition, not all conditions for knowledge transfer success have been explored in this study, and therefore further conditions may be identified and examined. The high consistency and coverage scores of the fsQCA results suggest confidence in the conclusion that the solutions illustrate the majority of the outcome across the cases, however, the remaining percentages not explained by solutions obtained suggest the influence of other conditions not included in this study, and further combinations that could contribute to knowledge transfer success. In particular, coverage scores for Multinational-SME partnerships could be higher, and this indicates that further research is required to determine further conditions and recipes for knowledge transfer success. Additional interviews are currently being conducted as part of this study to further investigate this aspect of the findings.

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