Team Disseminative Capacity: A Process Perspective

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Author’s Declaration

I, Shukrullah Fassehi, certify that:

This thesis has been substantially accomplished during enrolment in the degree.

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Abstract

Disseminative capacity (DCAP), defined as those processes that determine whether or not a team is able to effectively pass on knowledge to other teams and organisational units, has recently received increased attention in the literature. Extant research has predominantly conceptualised DCAP in terms of the characteristics of persons disseminating or sending knowledge to others, particularly their motivation (willingness to transfer knowledge), and ability (knowledge, skills, and expertise). Such conceptualisations provide a partial account of what might constitute a capacity to disseminate knowledge, however, and little is known about processes that constitute DCAP. In this thesis, I operationalised DCAP at the team level by identifying processes that are central to team DCAP. I conducted three empirical studies to explore the phenomenon. Study 1 (Chapter 3) is a qualitative study involving 34 narratives across five projects with members of disseminating and recipient teams. By collecting these narratives, I was able to uncover processes that were involved across these projects. I found that team DCAP constitutes three elemental processes of knowledge co-creation, implementation, and integration.

Drawing on the findings of Study 1, Study 2 (Chapter 4) is a process study whereby I tracked knowledge co-creation in real-time over 10 months. Data sources included non-participant observation of project meetings (over 10 months), a total of 37 narratives at three time intervals (T1, T2, and T3), archival data, and surveys. I found that elemental processes of knowledge co-creation include the involvement of the right stakeholders i.e., disseminating team, recipient team (and external contractors) that lead to knowledge diversity. The three diverse knowledge areas included strategic/technical knowledge, operational knowledge, and specialised knowledge of the disseminating team, recipient team, and external contractors respectively. Findings revealed that knowledge co-creation emerged as the function of the iterative and intertwined processes of perspective taking and collective sensemaking. Perspective taking refers to understanding the world through other individuals’ eyes, while collective sensemaking refers to arriving to a common understanding through interaction and exchange of
interpretations. Perspective taking and collective sensemaking emerged as iterative processes whereby perspective taking influenced collective sensemaking, and this led to better perspective taking at a later stage. The outcome that emerged as a function of perspective taking and collective sensemaking is co-created knowledge that has the following attributes i.e., multifacetedness, utility, shared ownership, and enhanced quality (MUSE). Key factors that enhanced knowledge co-creation included psychological safety climate, and team structure (i.e., formalisation of meetings, and role clarity). The key inhibiting factors of knowledge co-creation included risks and uncertainties.

Study 3 (Chapter 5) is a further exploratory study based on 31 narratives across seven projects with members of disseminating and recipient teams. In this study, I explored the implementation and integration processes of team DCAP. By adopting a process lens, I identified two trajectories: more effective and less effective knowledge integration trajectories. The more effective knowledge integration trajectory involved a collaborative effort of the disseminating team in terms of undertaking team DCAP processes. The team DCAP processes are further refined and include knowledge co-creation, co-implementation, co-integration, and co-evolution. The less effective knowledge integration trajectory involves those processes that are performed in isolation (with little or no involvement of recipients) throughout all team DCAP phases. In summary, this thesis contributes to a process view of team DCAP. Practical implications and direction for future research are also discussed.

Keywords: team disseminative capacity, process perspective, knowledge co-creation, co-implementation, co-integration, co-evolution
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Dedication

I dedicate this thesis to my beloved son Ali who was born during my PhD journey. Ali, you have inspired me to make this journey to the finish line.
**Authorship Declaration: Co-authored Publications**

This thesis contains work that has been published and/or prepared for publication.

| Details of the work: Team disseminative capacity: A process perspective on knowledge co-creation |
| Location in thesis: Study 1 (Chapter 3) |
| Student contribution to work: This chapter is prepared as a manuscript for *Organization Studies* journal. The candidate was responsible for data collection, data analysis, literature review, and write-up of the article. The overall work completed by the candidate constitutes approximately 70%. The project was supervised by Dr Christine Soo. She provided multiple rounds of feedback, and edited the manuscript on several occasions. Professor John Cordery also provided feedback, and edited the earlier version of the manuscript. Dr Julia Backmann and Professor Martin Hoegl contributed toward improvement of theoretical framework, provided valuable feedback, and edited the manuscript several times. |

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Date: 30/11/2018
## Conference Presentations

The thesis contains work that has been presented at two conferences.

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Chapter 1: General Introduction
1.1 Background

In today’s knowledge-based economy (Powell & Snellman, 2004), knowledge is considered to be a firm’s most important resource (Grant, 1996a; Inkpen & Tsang, 2016), a source of innovation (Bell, 1999), and competitive advantage (Argote & Ingram, 2000; Easterby-Smith, Lyles, & Tsang, 2008; Van Wijk, Jansen, & Lyles, 2008). For these reasons, the way knowledge is managed becomes instrumental to a firm’s growth and survival. This thesis aims to advance our understanding of team disseminative capacity (DCAP) and its processes, as manifested in teams. In this chapter, I use DCAP and disseminative capacity interchangeably. DCAP has typically been defined in terms of the characteristics of senders (those people disseminating their knowledge), and in particular their motivation and ability (Minbaeva, 2007; Minbaeva & Michailova, 2004; Schulze, Brojerdi, & Krogh, 2014). This characterisation highlights senders’ willingness to transfer knowledge, and the knowledge, skills, and expertise they possess, including their ability to teach and communicate. There are two issues that such a sender-focused perspective raises.

First, considering disseminative capacity solely in terms of attributes of senders provides an incomplete perspective on the knowledge transfer process. It implies that senders are the only source of knowledge, which runs counter to the knowledge-based view of the firm (Grant, 1996b; Spender, 1996) which argues that knowledge is dispersed and originates in many parts of the organisation (including knowledge recipients). Conceptualising disseminative capacity solely as a function of senders’ characteristics fails to take account of the role of recipients in the dissemination process. For example, in such a conceptualisation, an understanding of recipients’ needs and their prior knowledge can be overlooked. Additionally, one can infer from this characterisation that knowledge is a stable commodity that can be transmitted from senders to recipients. However, research points to the dynamic view of knowledge which concentrates on knowing—knowledge that is always in a state of
change and flux (Barley, Treem, & Kuhn, 2018; Ewenstein & Whyte, 2007; Kuhn & Jackson, 2008). The dynamic or practice-based view of knowledge calls upon collaboration among divisions of labour (Brown & Duguid, 2001), in terms of creating, modifying, disseminating, or integrating knowledge. Additionally, the emphasis of recent studies regarding the DCAP construct has primarily been concentrated at the individual (Minbaeva & Michailova, 2004), and firm levels (Schulze et al., 2014). In this thesis, I operationalise DCAP as a team-level construct. A key underlying reason is that knowledge dissemination and its implementation involve close interaction and coordination among different teams and units across an organisation.

Second, the extant DCAP literature (Minbaeva, 2007; Minbaeva & Michailova, 2004; Minbaeva, Park, Vertinsky, & Cho, 2018; Schulze et al., 2014) has predominantly adopted a variance perspective (e.g., more of X and more of Y generates more of Z and so on) which looks at the relationships between independent and dependent variables (Langley, 1999). According to Barley et al. (2018), a variance-based approach to knowledge management has two limitations, as follows: (a) it understates the dynamic ways that knowledge can be managed over time; and (b), it can confound the possibilities of generating differentiated knowledge, and outcomes at various levels of analysis. In contrast, a process-based approach takes into account the sequence of events, for instance do A, then B to achieve C and so on (Langley, 1999). In this way, a process approach facilitates an understanding of how knowledge emerges, and changes (Ewenstein & Whyte, 2007), and the roles of various actors involved in influencing that process (Pentland, 1999). As mentioned earlier, the review by Barley et al. (2018) also points to a need for a process perspective into how knowledge can be effectively managed.

The overarching objective of this thesis is to address these issues by exploring how team DCAP processes unfold. In doing so, I will focus on identifying key processes that contribute to team DCAP, and on the potential benefits that derive from this, both for
disseminating and recipient teams. By adopting a process lens, I propose that the sequence of activities that contribute to team DCAP is instrumental to knowledge transfer effectiveness.

1.2 Using the process lens to study team disseminative capacity

Whitehead (1929, p. 22) stated that “the actual world is a process, and that the process is the becoming of actual entities.” According to process philosophy, process is the core of reality (Nayak \& Chia, 2011). As such, organisation and organisational phenomena are viewed as nothing but unfolding processes (Tsoukas \& Chia, 2002; Van de Ven \& Poole, 2005; Weick, 1979), where these unfolding processes bring the past into the present and future (Nayak \& Chia, 2011). “Process questions take a researcher into a conceptual terrain of events, episodes, activity, temporal ordering, fluidity, and change” (Langley, Smallman, Tsoukas, \& Van de Ven, 2013, p. 10). Additionally, causality is established through a series of events rather than abstract correlations (Langley et al., 2013), as in variance-based studies. As mentioned earlier, most DCAP studies (Minbaeva, 2007; Minbaeva \& Michailova, 2004; Minbaeva et al., 2018; Schulze et al., 2014) have adopted a variance-based approach. As such, they have overlooked the temporal progression of activities (Langley et al., 2013) associated with knowledge dissemination. Therefore, there is a lack of understanding in terms of the order of processes that occur before knowledge dissemination, and how these processes can affect the dissemination process. Additionally, we know little in terms of processes that affect subsequent knowledge integration, and how these change or disrupt knowledge integration.

1.3 Overview of the chapters

This thesis comprises six chapters, and are structured as follows. In Chapter 2, I provide a review of the current state of literature on disseminative capacity, and the related body of research including knowledge transfer literature. This review serves two key objectives. First, it gives us an understanding of what we know from the DCAP literature, and the related fields of research that contribute to the development of the construct. Second, it seeks to direct us to
areas that we know little, and the key gaps that need to be addressed. Hence, Chapter 2 provides the background literature and underlying rationale for conducting this research. Chapters 3, 4, and 5 (Studies 1, 2 & 3) are empirical studies. These studies were conducted at the same organisation. There is no overlap in the data used in each study.

Chapter 3 (Study 1) addresses one crucial gap in the DCAP and knowledge transfer literatures. As mentioned earlier, there is a dearth of process research on DCAP. Therefore, we know little about the key processes that constitute DCAP, and the roles of disseminating and recipient teams in executing these processes. The study contributes to DCAP literature by incorporating a process view (Langley, 1999; Langley et al., 2013; Whitehead, 1929) into the study of team DCAP. I develop a team DCAP process model based on grounded research (Strauss & Corbin, 1990) that entails its core processes. The study revealed team DCAP processes as consisting of three elemental processes of knowledge co-creation, implementation, and integration. This conceptualisation not only provides an understanding of the sequential ordering of the processes (Langley et al., 2013; Van de Ven & Poole, 2005) that are central to DCAP, but also provides insight into the roles that both disseminating and recipient teams play in those processes. Thus, findings of Study 1 build upon existing understanding of DCAP which characterises “disseminative capacity” as the ability and willingness of senders to transfer knowledge. Central to team DCAP processes is knowledge co-creation which influences whether or not knowledge can be effectively disseminated.

In Chapter 4 (Study 2), I focus on knowledge co-creation, and track how it evolves over time. The underlying reason for exploring knowledge co-creation is that it is central to effective knowledge dissemination as found in Study 1. Therefore, Study 2 is important because by tracking knowledge co-creation in real-time over 10 months, I address three important gaps in the literature. First, there is a lack of research on sender-recipient knowledge co-creation, and how it unfolds over time. By bringing in process theory (Langley et al., 2013; Van de Ven &
Poole, 2005) into the study of knowledge co-creation, I contribute to the dynamic view of knowledge (Ewenstein & Whyte, 2007; Kuhn & Jackson, 2008). A second gap that Study 2 addresses is increasing our understanding of the diverse knowledge that disseminating team, recipient team, and external contractors have, and how it can complement the new knowledge that is created. By identifying the characteristics and importance of each party’s knowledge, I highlight the role of their collaborative effort (Bruns, 2013) in the knowledge co-creation process. Third, I identify the roles of actors i.e., disseminating team, recipient team (and external contractors), and demonstrate how their collective effort in the process of knowledge co-creation shapes the outcome (i.e., co-created knowledge).

Chapter 5 (Study 3) is a further exploratory study that delves deeper into the third team DCAP process—knowledge integration. In this study, I consider knowledge integration as the routinisation of knowledge (Szulanski, 1996). In light of viewing knowledge integration as the routinisation of knowledge, the study addresses two gaps in the literature. First, there is a lack of understanding of the processes that lead to effective knowledge integration. Second, there is little understanding of the role of different actors in terms of influencing the knowledge integration processes.

In addressing the first gap, the study brings in process theory (Langley, 1999; Langley et al., 2013; Van de Ven & Poole, 2005), and trajectory approach (Christianson, 2017; Faraj & Xiao, 2006; Strauss, Fagerhaugh, Suczek, & Wiener, 1985) into the study of knowledge integration. The study identifies two trajectories of actions that lead to more effective and less effective knowledge integration. In addressing the second identified gap, I bring in agency theory (Emirbayer & Mische, 1998), and performative perspective of routines (Feldman & Pentland, 2003) together to highlight the dynamic nature of routines. In other words, knowledge that is integrated into an organisation’s routines does not remain static (Ewenstein & Whyte, 2007). Rather, it goes through change, and this change is reflective of agency
(Emirbayer & Mische, 1998) i.e., specific actions taken by actors i.e., disseminating and recipient teams that can influence knowledge integration.

Finally, in Chapter 6, I discuss how the three empirical studies (Chapters 3, 4, and 5) collectively interconnect and contribute to a process understanding of team DCAP. Central to my conceptualisation of team DCAP is a process view which puts collaborative agency of disseminating and recipient teams in the spotlight. Additionally, I state the contributions of my research both to the DCAP and knowledge management literature in general, and to practice. Finally, I discuss the limitations of my research, and identify promising avenues for further research into team DCAP.
Chapter 2: Literature Review
2.1 Introduction: Defining knowledge transfer

Knowledge is frequently described as an organisation’s most important resource (Inkpen & Tsang, 2016) and a potential source of competitive advantage (Argote & Ingram, 2000). Findings based on meta-analysis revealed that when knowledge is effectively transferred, it leads to enhanced performance and innovation (Van Wijk et al., 2008). Knowledge transfer has generally been studied in intra- and inter-firm contexts (Amesse & Cohendet, 2001; Van Wijk et al., 2008). Within firms themselves, knowledge transfer commonly occurs between individuals, units (Gupta & Govindarajan, 2000; Schulz, 2003; Szulanski, 1996; Tsai, 2001) or teams (Argote & Ingram, 2000), such as the transfer of financial expertise or market-related knowledge (Wong, Ho, & Lee, 2008).

In an inter-firm context, knowledge transfer has been studied in joint ventures (Inkpen & Dinur, 1998; Lyles & Salk, 1996), mergers and acquisitions (Bresman, Birkinshaw, & Nobel, 1999), and strategic alliances (Grant & Baden-Fuller, 2004; Inkpen & Pien, 2006; Mowery, Oxley, & Silverman, 1996; Sampson, 2007). For instance, when firms form alliances, they pool their knowledge, skills, and other resources in achieving their common goal (Varadarajan & Cunnigham, 1995). Research suggests that knowledge transfer between firms is more difficult than within firms (Kogut & Zander, 1992). This difficulty is primarily due to the multifaceted nature of organisational boundaries, cultures and processes (Easterby-Smith et al., 2008).

In the relevant literature, various terms have been used interchangeably with knowledge transfer (Hansen, 1999; Tsai, 2002), including knowledge flows (Gupta & Govindarajan, 2000), knowledge dissemination (van der Bij, Song, & Weggeman, 2003), knowledge diffusion (Almeida, 1996), knowledge exchange (Cabrera, Collins, & Salgado, 2006), and knowledge deployment (Subramaniam & Venkatraman, 2001). According to Darr and Kurtzberg (2000, p. 29), knowledge transfer is enacted “when a contributor shares knowledge that is used by an adopter.” Put simply, knowledge transfer occurs when a group, unit or division of an
organisation is influenced by the knowledge or experience of another (Argote & Ingram, 2000; Argote, Ingram, Levine, & Moreland, 2000; Argote, McEvily, & Reagans, 2003; Van Wijk et al., 2008). When knowledge is transferred, this often leads to changes in the behaviour and performance of the knowledge recipient (Inkpen & Tsang, 2005). In the extant literature, the characteristics of knowledge, characteristics of senders, recipients, and inter-team relationships are often discussed, and the extent to which these affect knowledge transfer.

2.2.1 Characteristics of knowledge

Knowledge was described by Polanyi (1962a, 1962b) in terms of being explicit and tacit. Explicit knowledge is that which can be codified and communicated in words or numbers (Nonaka, Byosiere, Borucki, & Konno, 1994; Zander & Kogut, 1995), such as a manual containing instructions on the operations of a product (Alavi & Leidner, 2001). Tacit knowledge on the other hand is subjective (Nonaka & Takeuchi, 1995; Nonaka, Toyama, & Hirata, 2008; Polanyi, 1962a), context-specific (Nonaka & Takeuchi, 1995), and difficult to express in words (Ambrosini & Bowman, 2001; Tsoukas & Vladimirou, 2001). Polanyi (1962b, p. 239) described tacit knowledge in the following way:

There are things that we know but cannot tell [italics in original]. This is strikingly true for our knowledge of skills [italics in original]. I can say that I know how to ride a bicycle or how to swim, but this does not mean that I can tell how I manage to keep my balance on a bicycle or keep afloat when swimming.

Tacitness is considered to be a source of complexity which can make the imitation and transfer of knowledge difficult (Reed & Defillippi, 1990; Simonin, 1999b). While knowledge tacitness makes knowledge leakage outside the organisation less likely, it can also make the internal transfer of knowledge difficult (Coff, Coff, & Eastvold, 2006) because it is personalised i.e., embedded in individuals’ actions, context-specific, and difficult to be codified
Apart from characteristics of knowledge that affect knowledge transfer, the groups or teams that are involved in the transfer also influence the transfer process.

### 2.2.2 Characteristics of disseminating teams

Characteristics of disseminating teams have been described in terms of willingness and credibility (Dyer & Hatch, 2006; Minbaeva, 2007; Szulanski, 1996). Willingness relates to disseminating team’s rationale for disseminating knowledge. If the transaction does not lead to any benefits or outcomes, a disseminating team may disengage. Szulanski (1996) pointed out several reasons underlying an unwillingness to share knowledge, including (a) fear of losing ownership; position privileges, or power; (b) feelings of resentment or dissatisfaction (e.g., for not being adequately remunerated); and (c) reluctance to dedicate time and resources to transferring knowledge. There are other reasons that lead to the difficulty of transferring knowledge. For instance, an unwillingness to share knowledge can occur due to “an intraorganizational atmosphere of secrecy and competition” (Hansen, 1999). Credibility on the other hand can arise from disseminating team’s competency, that is, knowledge, skills, abilities, and other characteristics—KSAOs (Shippmann et al., 2000). Disseminating teams that are credible can be considered as reliable and trustworthy, and recipients are more likely to be willing to absorb their knowledge.

### 2.2.3 Characteristics of recipient teams

Key characteristics of recipient teams that can positively influence knowledge absorption include team absorptive capacity (ACAP) (Backmann, Hoegl, & Cordery, 2015; W. M. Cohen & Levinthal, 1990) and team motivation (Park, Spitzmuller, & DeShon, 2013). The concept of ACAP was initially proposed by W. M. Cohen and Levinthal (1989, p. 569), who defined it as the “ability to identify, assimilate, and exploit knowledge from the environment”. Subsequently, W. M. Cohen and Levinthal (1990, p. 128) offered a refined definition of ACAP as “the ability of a firm to recognize the value of new, external information, assimilate it, and
apply it to commercial ends.” The importance of ACAP to knowledge transfer effectiveness has been noted in previous research (Lane & Lubatkin, 1998; Szulanski, 1996).

### 2.2.4 Inter-team relationships

Inter-unit relationships refer to the informal interactions that take place between different groups of people (Hansen, 1999). In larger organisations with multiple units, searching for knowledge can be quite difficult; thus relationships between units become extremely important in locating useful knowledge (Hansen, 1999). Indeed, inter-unit relationships can function as a medium where knowledge can permeate to other parts of the organisation (Argote et al., 2003). Hansen (1999) found that ‘strong ties’ facilitate the transfer of complex knowledge, whilst ‘weak ties’ facilitate the transfer of new knowledge. Strong ties and weak ties can be distinguished in terms of the closeness and frequency of interactions between senders and recipients (Granovetter, 1973; Levin & Cross, 2004). To this end, strong ties refer to close and frequent interactions, whereas weak ties refer to distant relationships between senders and recipients (Hansen, 1999).

In an ethnographic study, Uzzi (1997) found that strong ties create a heuristic (a positive belief when interpreting others’ intentions and actions) that facilitates the transfer of knowledge. Thus, when relationships are stronger between two units or teams (i.e., disseminating and recipient teams), they are more likely to trust each other. In this sense, recipients have a positive expectation with respect to disseminating team’s intentions, motivation, and behaviour (Lewicki, Tomlinson, & Gillespie, 2006), and can trust that the knowledge they acquire from disseminating team is valuable—meaning that it can solve their problems, and does not pose any risks e.g., monetary or technical failures. Thus, recipients can accept and apply knowledge without challenging the accuracy of knowledge acquired from disseminating team (McEvily, Perrone, & Zaheer, 2003).
2.2.5 Knowledge transfer processes

Knowledge transfer is seldom a single event, and often entails lengthy processes (Szulanski, Ringov, & Jensen, 2016). Researchers have identified various stages in knowledge transfer processes, such as initiation, implementation, ramp-up, and integration (Szulanski, 1996, 2000), enrolment, preparation, trials, and reflection (Edmondson, Bohmer, & Pisano, 2001), and searching for knowledge (Hansen, 1999; Hansen, Mors, & Løvås, 2005). More recently, Szulanski et al. (2016) coined two additional transfer modes—front-loading and back-loading, which are distinguished in terms of four processes (interaction between sender and recipient, personalised communication, recipient’s observation of knowledge, and recipient’s practice of knowledge) that either occur during initiation or implementation phases (Szulanski et al., 2016). When these four processes occur during the initiation phase, it is referred to as front-loading (Szulanski et al., 2016). Whereas, if these four dimensions occur during the implementation phase, it is referred to as back-loading (Szulanski et al., 2016). For the purpose of this review, I emphasise primarily on the four-stage model (Szulanski, 1996, 2000) because it points to the core processes that occur before the transfer process (initiation), during the transfer process (implementation), and post transfer processes (ramp-up and integration).

Initiation involves identifying recipients’ needs (Szulanski, 1996, 2000), and searching for expert knowledge to address those needs (Hansen et al., 2005). The search for expert knowledge brings together relevant and valuable knowledge dispersed among team members and sub-units (Hansen et al., 2005; Teece, 1986). Szulanski (1996, 2000) referred to “implementation phase” whereby transfer is enacted. During this phase, the teams incur transfer-related costs i.e., number of engineering resources spent for transfer (Hansen et al., 2005). The “ramp-up” phase (Szulanski, 1996, 2000) is analogous to the “support of knowledge application” dimension of knowledge transfer (Schulze et al., 2014). According to Szulanski (2000), teams may encounter problems as a result of knowledge transfer for a number of
reasons: (a) unanticipated issues may arise because the knowledge is transferred in a different environment; (b) staff may receive inadequate training to apply the knowledge; (c) trained staff may exit the organisation and/or are incompetent for the new role; and (d) newly transferred knowledge involves a substantial change in shared language and culture (e.g., shared norms and beliefs). This can be problematic in terms of embedding knowledge into the organisation’s daily system, particularly when recipients lack a deep understanding of the knowledge. It follows that disseminating teams should provide support by visiting recipients and troubleshooting problems when needed (Szulanski, 2000). Finally, knowledge integration occurs when knowledge becomes institutionalised (Lanzara & Patriotta, 2007), and embedded into an organisation’s routines (Szulanski, 1996, 2000).

Despite the bulk of research that has adopted a process perspective (Edmondson et al., 2001; Hansen, 1999; Hansen et al., 2005; Szulanski, 1996, 2000; Szulanski et al., 2016), there is still a need for further study to distinguish the various transfer phases (Van Wijk et al., 2008). Specifically, we lack understanding of how the various phases or processes of knowledge transfer influence subsequent processes, and how these processes shape the outcome. More importantly, the role of recipients in the transfer process are not explicitly identified, and as such, their capability to influence the transfer process by and large has remained underestimated. In the most recent review, Barley et al. (2018) suggested that a process perspective is better suited to studying knowledge management, because it can capture the dynamic nature of knowledge. Considering knowledge as a dynamic phenomenon recognises that knowledge is not an object or commodity that is attached to individuals or groups (Barley et al., 2018; Lave, 1988), rather it is “constituted and reconstituted everyday in practice” (Orlikowski, 2002, p. 269). Thus, the dynamic nature of knowledge can be better explored by adopting a process lens. As mentioned earlier, there is a dearth of research adopting a process perspective on DCAP. Additionally, studies that have adopted a process perspective on
knowledge transfer at the intra-firm level have not made explicit attempts to identify ways in which recipients influence the transfer processes. In what follows, I will discuss the importance of a process perspective and how it can enrich the investigation into disseminative capacity.

2.3 Disseminative capacity

Disseminative capacity is defined as the sender’s ability and willingness to transfer knowledge (Minbaeva, 2007; Minbaeva & Michailova, 2004) in such a way that it can be understood and applied by recipients (Mu, Tang, & MacLachlan, 2010; Schulze et al., 2014; Tang, 2011; Tang, Mu, & MacLachlan, 2010). The terms disseminative capacity (Minbaeva, 2007; Minbaeva & Michailova, 2004; Minbaeva et al., 2018; Minbaeva, Pedersen, Björkman, & Fey, 2014; Mu et al., 2010; Tang et al., 2010), and disseminative capability (Schulze et al., 2014), have been used interchangeably. This is in part due to the belief that extant research ascribes the same meaning to capability and capacity. In simple terms, capabilities are what organisations can do (Zander & Kogut, 1995) by applying their relevant knowledge, experience and skills (Richardson, 1972). At the team level, these capabilities can be manifested when cross-functional teams pool together their expertise and differentiated knowledge in the development of a product (Eisenhardt & Martin, 2000). In the present thesis, I adopt the term disseminative capacity (DCAP) because it has been more commonly used in the literature. Throughout this chapter, I will use DCAP and disseminative capacity interchangeably.

Minbaeva and Michailova (2004) and Minbaeva (2007) considered senders’ characteristics (i.e., motivation and ability) to constitute DCAP. Subsequently, Minbaeva et al. (2018) expanded on their earlier conceptualisation, and refined DCAP to include articulation and codification abilities with the use of appropriate communication channels. Schulze et al. (2014) pointed to DCAP as the teaching capability of senders, and identified five DCAP dimensions as follows: attainment of expert knowledge, assessment of recipients’ knowledge, detachment of knowledge, ability to encode knowledge, and support of knowledge application.
Schulze et al. (2014) developed these five dimensions by drawing insight from the education and knowledge transfer literatures. While there is no general consensus as to what exactly constitutes DCAP, the dominant themes that have emerged so far include senders’ motivation, ability, and their teaching capability.

Despite the growing interest into DCAP, it is still relatively underdeveloped as an area of theory (Minbaeva et al., 2018; Schulze et al., 2014), and the bulk of empirical research (Minbaeva, 2007; Minbaeva & Michailova, 2004; Schulze et al., 2014) in this field so far has primarily adopted a variance-based approach which looks at relationships among independent and dependent variables (Mohr, 1982; Van de Ven, 1992). The knowledge transfer processes that underpin DCAP have largely been neglected in the literature.

### 2.4 Process perspective on disseminative capacity

Whitehead (1929, p. 208) recognised “the flux of things” and that ‘all things flow’ [inverted comma in original]. Process is commonly defined as “a sequence of individual and collective events, actions, and activities unfolding over time in context” (Pettigrew, 1997, p. 338). The process perspective emphasises on the sequential order of things and how they unfold over time (Langley et al., 2013; Van de Ven, 1992; Van de Ven & Poole, 1990), for instance, do A, then B to achieve C (Langley, 1999). Seeing the world through a process lens connotes that the human world revolves around mutable events rather than stable structures (Cooper, 2007). Central to process theorizing is the notion of time, which is largely taken for granted in variance-based research (Langley et al., 2013). Variance-based research investigates relationships among dependent and independent variables, that is the extent to which an independent variable causes changes to a dependent variable (Langley, 1999; Van de Ven & Poole, 2005). The objective of variance studies is to “explain and/or predict the occurrence and magnitude of change, or the effects of change, on other variables” (Van de Ven & Poole, 2005, p. 1383). Variance studies generate linear models by applying statistical techniques such as
ANOVA, regression, factor analysis, and structural equation modelling (Van de Ven & Poole, 2005). Such a linear way of thinking can limit our understanding of the dynamic nature of knowledge, and blur the possibility of discerning the phenomenon across different levels of analysis (Barley et al., 2018). Thus, by adopting a process perspective, this thesis provides a more in-depth understanding of DCAP processes at the team level by taking into account the notion of time e.g., how knowledge emerges, and changes (Ewenstein & Whyte, 2007), and the roles of various actors involved (Pentland, 1999) in the knowledge dissemination process.

As I mentioned earlier, there is an enormous opportunity for further advancement of our understanding of disseminative capacity by viewing it through a process lens (Barley et al., 2018). There are three key reasons as to why a process perspective is important for investigating disseminative capacity. First, the bulk of research on DCAP has employed a variance-based approach (Minbaeva, 2007; Minbaeva & Michailova, 2004; Minbaeva et al., 2018; Schulze et al., 2014; Tang, 2011; Tang et al., 2010) which is typically appropriate for addressing questions relating to antecedents and outcomes (Pentland, 1999). However, process studies address more complex questions that relate to how and why a phenomenon arises and has its effect (Langley et al., 2013; Mohr, 1982). For instance, disseminative capacity has primarily been studied in terms of the ability and willingness of senders to transfer knowledge. Relying solely on these variables (and not associated processes) is unlikely to give us an in-depth understanding of the complexities involved in transfer of knowledge.

Second, by employing a process perspective, I emphasise the importance of agency, which is central to any process-based analysis (Pettigrew, 1997). Action or agency has “reference to the activities of an agent, and cannot be examined apart from the broader theory of the acting self” (Giddens, 1979, p. 55). For instance, Anand, Gardner, and Morris (2007) noted the importance of agency as the cornerstone of innovation in knowledge-intensive organisations. With regard to the way DCAP is conceptualised in the literature, the primary
agent that drives the action (knowledge dissemination) is commonly considered as the sender. This form of conceptualisation can only give a partial account of the complexity involved in the knowledge dissemination phenomenon. An equally important agent is the recipient, whose role is largely understated in extant research, and is often merely discussed in terms of their absorptive capacity (W. M. Cohen & Levinthal, 1990). Apart from being the recipient of knowledge, recipients too can contribute by offering their practical knowledge. However, this valuable knowledge can only be leveraged if the actors (disseminating and recipient team members) collaboratively engage in the creation and transfer of knowledge.

Finally, process research has opened up the black box of organisational life and this offers efforts to be directed more toward a micro level of analysis (Johnson, Melin, & Whittington, 2003; Whittington, 1996). A micro level of analysis can be defined in terms of having a “closer observation of the underlying individual processes that generate routine action” (M. D. Cohen, 2012, p. 1383). For instance, the context within which the interactions take place (Felin, Foss, & Ployhart, 2015) can provide important insights with respect to why certain processes in certain situations lead to effective knowledge transfer. In this way, there is a greater possibility of getting a fine-grained understanding of disseminative capacity.

In addressing the gaps identified, this thesis aims to address the research question: What are effective team DCAP processes and how do they unfold? The key rationales for exploring DCAP processes at the team level are two-fold. First, interest in teamwork over the past several decades has increasingly been growing due to the myriad reasons e.g., increase in global competitiveness, complexity of organisational environments demanding a high level of expertise and knowledge diversity, and a decline in bureaucratic form of organisational structures (Kozlowski & Ilgen, 2006; Mathieu, Hollenbeck, Van Knippenberg, & Ilgen, 2017). Team, which is defined as a collective of individuals performing organisationally relevant tasks, share common goals, and demonstrate task interdependencies (Kozlowski & Bell, 2003)
can gain an optimal outcome through coordination (Brannick, Prince, Prince, & Salas, 1995; Rico, Sánchez-Manzanares, Gil, & Gibson, 2008) and collaboration (Bruns, 2013). To this end, team DCAP, which I define as those processes that determine whether or not a team is able to effectively disseminate knowledge to other teams and organisational units requires teamwork. Thus, understanding team processes is important to understanding DCAP because much of knowledge dissemination happens within teams. Second, we need to understand how collaborative processes within teams (especially sender-user collaborations) influence DCAP processes. Therefore, in the next three studies (Chapters 3, 4, and 5), I address the gaps identified by highlighting the processes that are central to team DCAP.
Chapter 3: Team Disseminative Capacity: A Process Perspective on Knowledge Co-Creation

This chapter is prepared as a manuscript for *Organization Studies* journal. The candidate was responsible for data collection, data analysis, literature review, and write-up of the article (this constitutes approximately 70% of overall work completed by the candidate). The project was supervised by Dr Christine Soo. She provided multiple rounds of feedback, and edited the manuscript on several occasions. Dr Julia Backmann and Professor Martin Hoegl contributed toward improvement of theoretical framework, and edited the manuscript several times.

3.1 Abstract

This study investigates the concept of team disseminative capacity (DCAP), that is, a collaborative effort of disseminating and recipient teams in terms of co-creating knowledge, and subsequently disseminating it to recipients. I employed an exploratory study drawing on 34 semi-structured interviews with members of knowledge-disseminating and recipient teams at a large multinational firm in Australia. Adopting a process perspective, the study focuses on how teams disseminate the knowledge they have absorbed to other teams and sub-units across the organisation. Findings of the study indicate that team DCAP involves the processes of knowledge co-creation, implementation, and integration. I found that intra-organisational knowledge transfer (team to team) is more effective when that knowledge is co-created. Drivers of team DCAP include characteristics of knowledge, features of disseminating and recipient teams, psychological safety climate, and the nature of inter-team relationships. Implications of the study’s findings are also discussed for theory and practice.

*Keywords*: team disseminative capacity, knowledge transfer, process research
3.2 Introduction

"Do not send technology, bring it" (Manager)

—A quote from an interview

Generally, intra-organisational knowledge transfer is considered ineffective when it follows a fragmented process—where disseminating teams develop knowledge in isolation before disseminating it to recipient teams. The quote above illustrates that knowledge that is developed without the involvement of recipients is akin to a “package”. Knowledge that is sent to recipients in this way not only manifests a lack of recipient engagement (Metiu & Rothbard, 2013), but also means that recipients’ needs, concerns, interests, and knowledge have not been taken into account. Consequently, knowledge that is developed and “packaged” in this fashion is unlikely to effectively solve recipients’ problems. On the other hand, the “bring” element of the quote mentioned above implies a sense of “interaction” with recipients that can be delineated in the context of knowledge transfer as the disseminating team’s effort in involving recipients early, engaging them in decision making, and allowing them to have input in the transfer process and hence influence outcomes. To address this phenomenon, I explore team disseminative capacity (DCAP)—the extent to which teams can effectively pass on knowledge to other teams and/or units within an organisation.

In the past two decades, a number of studies have sought to investigate DCAP empirically (Minbaeva, 2007; Minbaeva & Michailova, 2004; Mu et al., 2010; Schulze et al., 2014; Tang, 2011; Tang et al., 2010) and conceptually (Bapuji & Crossan, 2005; Li, 2010; Schwartz, 2007). Among these, Schulze et al. (2014) and Tang et al. (2010) define DCAP as the ability of knowledge holders to transfer knowledge in such a manner that recipients can easily comprehend. Mu et al. (2010, p. 33) define DCAP as “the ability of network members (knowledge holders) to efficiently and effectively codify, articulate, communicate, and teach to other network members.” While Schulze et al. (2014), Minbaeva and Michailova (2004), Tang et al. (2010), and Mu et al. (2010) provide an important conceptual foundation (i.e.,
motivation and ability of senders) to the concept of DCAP, they do not investigate the processes that represent DCAP. I posit that the processes of DCAP should be placed centre stage in order to conceptualise and operationalise the construct. Surprisingly, no study to date has investigated the processes of DCAP and as a result, we have a lack of understanding of what constitutes effective DCAP processes and how they unfold over time.

In addition, extant studies on DCAP have been conducted primarily at the level of the individual (Minbaeva, 2007; Minbaeva & Michailova, 2004) and the firm (Schulze et al., 2014). While Schulze et al. (2014) acknowledge organisational members’ capabilities as central to DCAP, they nevertheless regard it as a firm-level construct. I build on Schulze et al.’s (2014) research and consider DCAP as a team-level construct. Because organisations are generally comprised of sub-units or teams, the initial point of knowledge acquisition is frequently at team/sub-unit level (Backmann et al., 2015). The knowledge acquired by the team must then be disseminated across other teams and sub-units if it is to permeate the organisation as a whole (van der Bij et al., 2003). In order to transfer innovative routines, best practices, and technologies to other parts of the organisation, teams must have a process for systemic knowledge transfer. This is best conceptualised as what I propose to call *team DCAP*. Therefore, I explore DCAP processes at the team level of analysis because this is a gap in the extant literature.

I concur with Schulze et al. (2014) and Tang (2011) that DCAP is an under-researched phenomenon; hence there are a number of gaps that need to be filled. To address the outlined gaps in extant research, I unpack the black box of DCAP at the team level to identify how the development of team disseminative capacity contributes to effective intra-organisational knowledge dissemination. In so doing, I apply a process perspective and acknowledge that team disseminative capacity (DCAP) is a collective effort involving disseminating and recipient teams, which encompasses undertaking a series of elemental processes so that
knowledge can be effectively passed on to recipients. The elemental processes are those overarching processes that constitute the crucial activities undertaken by members of disseminating and recipient teams. Therefore, the present study seeks to answer the following: What are effective team DCAP processes and how do they unfold?

By addressing these gaps and the outlined research question, I further develop the construct and contribute to the literature in three important ways. First, existing DCAP studies have adopted a predominantly variance approach that explains phenomena in terms of relationships among dependent and independent variables e.g., more of X and more of Y generate more of Z and so on (Langley, 1999). For instance, Schulze et al. (2014) investigated a set of important variables that included attainment of expert knowledge, assessment of recipients’ knowledge, detachment of knowledge, ability to encode knowledge, and support of knowledge application, treating these as antecedents to knowledge transfer success. I build on Schulze et al.’s (2014) research by adopting a process perspective. Contrary to a variance approach, a process perspective places emphasis on the order of events in which they unfold e.g., do A, then B to achieve C (Langley, 1999; Mohr, 1982). Understanding “temporal progressions of activities” (Langley et al., 2013, p. 1) helps us to identify the sequence of key actions and their impact on subsequent processes (Pettigrew, 1997) that are central to DCAP. In addition, the outcomes are explained in terms of “who does what when and what happens next” (Langley & Tsoukas, 2010b, p. 8). In this way, we can capture meanings that are constructed from events experienced by the actors (Rhodes & Brown, 2005) to gain a deeper understanding of the intricacies that exist in the transfer of knowledge from disseminating teams to recipient teams.

Second, there is conceptual ambiguity in existing research in terms of what constitutes DCAP. For instance, (1) are there certain processes that constitute DCAP; or (2) are there certain characteristics that constitute DCAP? Answering these questions is not an easy undertaking. Minbaeva (2007) and Minbaeva and Michailova (2004) conceptualise DCAP in
terms of senders’ characteristics (e.g., motivation and ability). On the other hand, Schulze et al. (2014) viewed DCAP in terms of five dimensions i.e., attainment of expert knowledge, assessment of recipients’ knowledge, detachment of knowledge, ability to encode knowledge, and support of knowledge application. In addition, Schulze et al. (2014) and Tang et al. (2010) consider DCAP largely as the teaching capability of senders. I contend that although teaching capability is an important element of DCAP, there is a need for more understanding in terms of the timing of teaching that needs to be undertaken in the dissemination process. Taken together, current literature has not explored the dynamic nature of DCAP. That is, the question of what processes constitute DCAP and how they unfold over time remains unanswered. Employing a process perspective, I posit that team DCAP constitutes a series of elemental processes. This form of conceptualisation allows us to develop a richer understanding of the logic behind temporal progressions (Langley et al., 2013; Van de Ven & Poole, 2005) of team DCAP processes.

Third, although extant literature points to a series of knowledge transfer phases i.e., initiation, implementation, ramp-up, and integration (Szulanski, 1996, 2000), front-loading and back-loading (Szulanski et al., 2016), such phases do not explore the nuances of micro-processes (specific actions that contribute to the effectiveness of the overarching processes) that unfold, and the agency of disseminating and recipient teams’ collaborative effort in executing these processes. For instance, Szulanski (1996) state that the initiation phase involves identifying recipients’ needs and finding expert knowledge to meet the needs. However, many questions still remain unresolved – for example, how can expert knowledge be acquired to address recipients’ needs? What knowledge resources can be drawn from recipients to aid the transfer process? How do recipients and disseminating teams collaboratively develop knowledge that can be usefully applied by recipients? This study contributes by providing
insights into DCAP processes as it goes beyond identifying the overarching elemental processes, but also considers the micro-processes underlying each of them.

The rest of the paper is structured as follows. First, I review existing literature on DCAP and knowledge transfer and highlight gaps in the literature that needs to be addressed. Second, I describe data collection method, data analysis, and coding protocols in my empirical investigation. Third, I present the findings based on my empirical investigation. Next, I discuss the findings by highlighting theoretical and practical implications, research limitations and directions for future research. I conclude the paper by accentuating the study’s key contributions.

3.3 Theoretical background

Although DCAP has attracted increased interest in the last two decades, the concept is still under-developed, both conceptually and empirically. Some studies have conceptualised DCAP in terms of senders’ characteristics. For instance, Minbaeva and Michailova (2004) and Minbaeva (2007) viewed senders’ ability and willingness to transfer knowledge as the determinants of DCAP. Other studies (Mu et al., 2010; Tang, 2011; Tang et al., 2010) have drawn on simulation data in studying DCAP. For instance, Tang et al. (2010) showed that senders’ DCAP and recipients’ absorptive capacity (ACAP) are important to knowledge transfer effectiveness. Mu et al. (2010) and Tang (2011) showed that knowledge equilibrium (the extent to which recipients have the same knowledge base as senders) depends on network size, knowledge transfer speed, senders’ DCAP and recipients’ ACAP. While these studies emphasise the importance of DCAP in relation to ACAP, they are silent on how DCAP can be enacted in practice. More recently, Schulze et al. (2014) investigated inter-organisational knowledge dissemination between teams and observed DCAP as a flip side of ACAP. Schulze et al. (2014) identified five dimensions to DCAP as mentioned earlier. These five dimensions were treated as antecedents of knowledge transfer success (Schulze et al., 2014). While these
dimensions can serve as important building blocks of team DCAP, more research is needed to explicate the order in which those dimensions can be enacted.

Another stream of research that is related to DCAP is the knowledge transfer literature. In the relevant literature, various terms have been used interchangeably with knowledge transfer (Hansen, 1999; Tsai, 2002), including knowledge flows (Gupta & Govindarajan, 2000), knowledge dissemination (van der Bij et al., 2003), knowledge diffusion (Almeida, 1996), knowledge exchange (Cabrera et al., 2006), and knowledge deployment (Subramaniam & Venkatraman, 2001). In this study, I use the term knowledge transfer to refer to the process in which small groups such as work teams or small departments are influenced by the knowledge, skills, or expertise of other small groups (Van Wijk et al., 2008). According to Darr and Kurtzberg (2000, p. 29), knowledge transfer is enacted “when a contributor shares knowledge that is used by an adopter.” This often leads to changes in the behaviour and performance of the knowledge recipient (Inkpen & Tsang, 2005), and can be enacted by various means, including rotation of individual team members (Kane, Argote, & Levine, 2005), training (Moreland & Myaskovsky, 2000), and technology transfer (Galbraith, 1990).

Current literature has outlined various knowledge transfer phases, which include initiation, implementation, ramp-up, and integration (Szulanski, 1996, 2000), deciding to seek knowledge, searching knowledge—an activity that involves the identification and evaluation of knowledge, and transferring knowledge (Hansen, 1999; Hansen et al., 2005). Initiation involves identifying recipients’ needs (Szulanski, 1996, 2000), and searching for expert knowledge to address those needs (Hansen et al., 2005; Schulze et al., 2014). The search for expert knowledge brings together relevant and valuable knowledge dispersed among team members and sub-units (Hansen et al., 2005; Schulze et al., 2014; Teece, 1986). Additionally, assessment of recipients’ knowledge (Schulze et al., 2014) is critical, as it informs the disseminating team’s understanding of recipient teams’ ACAP (Backmann et al., 2015; Zahra
& George, 2002) and identifies the common knowledge. Common knowledge refers to knowledge that is likely to be shared by organisational members or units (Grant, 1996b). The significance of common knowledge is that organisational members or units are able to share those packets of knowledge that are new to organisational members or units based on their shared understanding about each other’s realm of knowledge (Grant, 1996b).

Szulanski (1996, 2000) referred to “implementation phase” whereby transfer is enacted. During this phase, the teams incur transfer-related costs i.e., number of engineering resources spent for transfer (Hansen et al., 2005). Various transfer methods can be used that include, but are not limited to, face-to-face, intensive or regular site visits, as well as email, and other technology-based forms of transfer. For instance, Callahan, Kiker, and Cross (2003) examined the effects of instructional methods (i.e., lecture, modelling, and active participation) and instructional factors (i.e., materials, feedback, pacing, and group size) on training performance. The transfer method adopted depends on the disseminating team’s ability to assess recipient’s absorptive capacity (W. M. Cohen & Levinthal, 1990) and selecting an appropriate method of transfer accordingly. The effectiveness of a given transfer method may depend on the situation and purpose (Callahan et al., 2003). For instance, the lecture method may be more appropriate when presenting corporate policies while active participation method may be more appropriate in computer training (Callahan et al., 2003) or technology transfer scenarios. More recently, Szulanski et al. (2016) examined the extent to which timing of method can influence transfer stickiness and found that by interacting, communicating, observing, and allowing recipients to practice, transfer of tacit knowledge can be facilitated.

The “ramp-up” phase (Szulanski, 1996, 2000) is analogous to the “support of knowledge application” dimension of knowledge transfer (Schulze et al., 2014). According to Szulanski (2000), teams may encounter problems as a result of knowledge transfer for a number of reasons: (a) unanticipated issues may arise because the knowledge is transferred in a
different environment; (b) staff may receive inadequate training to apply the knowledge; (c) trained staff may exit the organisation and/or are incompetent for the new role; and (d) newly transferred knowledge involves a substantial change in shared language and culture (e.g., shared norms and beliefs). This can be problematic in terms of embedding knowledge into the organisation’s daily routine, particularly when recipients lack a deep understanding of the knowledge. It follows that disseminating teams should provide support by visiting recipients and troubleshooting problems when needed (Szulanski, 2000).

Knowledge integration phase relates to the routinisation of knowledge (Szulanski, 2000). The integration process allows team members to develop shared understanding about one another’s mental models, and coordinate actions (Chadwick & Raver, 2015) in terms of performing routines. During this phase, disseminating teams may draw on the transfer experience to enhance prospective transfer processes, based on the lessons learnt. For instance, the feedback loop is an effective mechanism for the integration of ideas (Pisano, 1994), in which team members reflect on their experience and share ideas, insights, and methods that they employed during the knowledge transfer process. According to Eppler and Sukowski (2000), to improve future knowledge transfer activities, disseminating teams need to ask the following key questions: (1) What worked? (2) What did not work? (3) How can we do differently, based on the lessons we have learnt from our experience? These lessons can then be documented and applied to improve future knowledge transfer endeavours.

3.3.1 Drivers of knowledge transfer

Previous studies have examined a range of factors that can influence the knowledge transfer process (Easterby-Smith et al., 2008; Ko, Kirsch, & King, 2005; Van Wijk et al., 2008), namely the characteristics of knowledge, characteristics of disseminating and recipient teams, and emergent states (i.e., psychological safety climate and relationship).
Characteristics of knowledge are discussed in terms of value and tacitness. Pérez-Nordtvedt, Kedia, Datta, and Rasheed (2008) employed the resource-based view (RBV) of competitive advantage (based on value, rareness, inimitability, and non-substitutability) to examine knowledge recipients’ willingness to learn. Their findings revealed that a knowledge recipient is more likely to absorb knowledge if it is valuable and of practical significance. According to Szulanski (1996), knowledge that has been proven to be valuable and tested, facilitates the transfer process. However, if this valuable knowledge is inherently tacit, transfer can be onerous. The classification of knowledge into explicit and tacit was first articulated by Polanyi (1962a). Explicit knowledge is knowledge that can be transferred in a formal and systematic manner (Nonaka, 1994), and can be “articulated, codified, and communicated in symbolic form and/or natural language” (Alavi & Leidner, 2001, p. 110). Tacit knowledge, on the other hand, is knowledge that is difficult to define (Szulanski & Winter, 2002), deeply personalised, and hard to formalise (Nonaka & Konno, 1998).

Existing literature has referred to characteristics of disseminating teams, such as their motivation and credibility. The decision of disseminating teams to engage in knowledge transfer depends in part on their motivation (Osterloh & Frey, 2000; Szulanski, 1996). Szulanski (1996) pointed out several reasons underlying an unwillingness to share knowledge, including (a) fear of losing ownership; position privileges, or power; (b) feelings of resentment or dissatisfaction (e.g., for not being adequately remunerated); and (c) reluctance to dedicate time and resources to transferring knowledge. Credibility is also a key factor in transferring valuable knowledge; the credibility of disseminating teams is influenced by the extent to which they demonstrate knowledge, skills, and expertise in the relevant domain. In the words of Rhee and Fiss (2014, p. 1739), “it matters who is speaking.” Knowledge from a source that is perceived to be reputable (Srinivasan & Kurey, 2014) has a better prospect of being absorbed by recipients.
Characteristics of recipient teams have been discussed in terms of motivation and ACAP (Szulanski, 1996). A key determinant of knowledge absorption is team motivation—the combined and interdependent determination of team members in pursuing their shared goal (Park et al., 2013). Motivated individuals tend to work harder (Roberts, Il-Horn, & Slaughter, 2006) and behave more proactively (Parker, Bindl, & Strauss, 2010) in acquiring valuable knowledge.

Some studies have referred to emergent states e.g., psychological safety climate (Mathieu, Maynard, Rapp, & Gilson, 2008), and inter-team relationship (Reagans & McEvily, 2003) as factors affecting team-level interactions. Edmondson (1999, p. 354) defines team psychological safety as “a shared belief that the team is safe for interpersonal risk taking.” In a psychologically safe climate, teams can openly express their views without fear of being judged or marginalised (Garvin, Edmondson, & Gino, 2008). Such a climate can promote effective knowledge transfer and learning behaviour in disseminating and recipient teams. Further, in order to improve the extent of knowledge transfer, organisations need to invest in building relationships to facilitate the transfer of tacit knowledge (Van Wijk et al., 2008). Distinguishing between weak and strong inter-unit relationships, Hansen (1999) found that strong relations are positively associated with the transfer of complex knowledge, while weak relations suffice for simpler content.

Having reviewed the literatures on DCAP and knowledge transfer, it has become apparent that there is a lack of process understanding of DCAP. As a result of this limitation, we do not know exactly what processes represent DCAP. As stated earlier, process models manifest “temporal progressions of activities” (Langley et al., 2013, p. 1) providing insight into the historical narratives (Abbot, 1988). Additionally, there is a dearth of research that conceptualises DCAP at the team level. Therefore, a deeper understanding of DCAP processes and role of actors i.e., disseminating and recipient team members, in influencing these
processes is currently lacking in the extant literature. In the context of team DCAP, the role of interactions between disseminating team and recipient team members in influencing the processes is particularly important.

Moving forward in the field, I argue that a fundamental step in understanding team DCAP is to identify its processes. Thus, this study explores the various team DCAP processes and drivers by adopting a process perspective. I argue that a process perspective of team DCAP is needed to help us better understand the complexities associated with the phenomenon. A key underlying reason is that team DCAP does not involve an isolated set of activities carried out by disseminating team members. Rather, it can involve iterative processes that are collectively undertaken by both disseminating and recipient teams. Therefore, this dyadic pattern of interactions between disseminating and recipient teams requires a process perspective (Langley et al., 2013) to demonstrate the dynamics of team DCAP processes. I address gaps in the extant research by delving deeper into the “black box” of what constitutes team DCAP processes. In doing so, I add to the understanding of team DCAP processes that unfold, how they are related to each other, and the role of disseminating and recipient teams in these processes.

3.4 Method

3.4.1 Research setting

This research was conducted at a large multinational mining firm in Australia. Structurally, the organisation comprises geographically dispersed units. The organisation places high emphasis on knowledge dissemination among its employees. The organisation has one designated unit whose primary role involves technology development, dissemination and technology-related support services for other units across the organisation. Therefore, “senders” are from this particular unit of the organisation. The technology development unit works hand in hand with other parts of the organisation in the development and dissemination
of new technologies with the aim to increase the efficiency of mining productions. Therefore, knowledge dissemination is an important feature of this knowledge-intensive organisation.

### 3.4.2 Data collection

For the purpose of this study, five recent (i.e., in the past 2 years) technology transfer initiatives (labelled technologies A to E in Appendix A) were investigated in terms of their underlying processes and drivers. For each transfer initiative, I interviewed two or three members of disseminating teams and two or three members of recipient teams, using a separate set of questions for each (see Appendix B for interview protocol). Attention was given to ensure that key personnel involved in each transfer initiative were included in the sample. In all, 14 members of disseminating teams and 12 members of recipient teams were interviewed (details of informants are outlined in Appendix A). In addition, eight interviews were conducted with key informants (i.e., senior managers/scientists) who had a comprehensive understanding of all five transfer initiatives and were members of both disseminating and recipient teams as they had previously worked in both roles. These key informants demonstrated deep knowledge of what constituted effective knowledge dissemination from both disseminating and recipient teams’ perspectives.

A total of 34 interviews were conducted, each lasting approximately 60 minutes, which were recorded and transcribed verbatim. Among the interviewees, the average tenure at the organisation was 17.5 years, and the average tenure at their current position was 5.6 years, indicating a sufficient level of understanding about the organisation and its knowledge dissemination processes. The interviews asked respondents to reflect on the implementation of specific technologies that had occurred in the past. However, the technologies that were implemented were not in distant past and informants were able to recollect the key events and processes that unfolded for each of the technology. In some instances, respondents’ recollections were aided with documents or folders related to the technologies on their
respective computers. Additionally, I minimised cognitive biases by triangulation. That is, I interviewed members of disseminating and recipient teams, and other key informants for each technology. Therefore, the types of questions that were posed (i.e., how and why), helped me capture meaningful narratives that demonstrated temporality as constructed by accounts of the informants (Fachin & Langley, 2017).

Using a process research method (Langley et al., 2013), I explored the processes of team DCAP. The process story emerged from narratives (Czarniawska, 1995; Rhodes & Brown, 2005) whereby informants engaged in sensemaking and reconstructed their experiences (Fachin & Langley, 2017). Treating each knowledge dissemination activity as a critical incident (Flanagan, 1954), members of disseminating teams were asked to reflect on the processes adopted to disseminate knowledge, and the factors that enhanced or constrained knowledge dissemination. Similarly, recipient team members were asked to reflect on the transfer processes used by disseminating teams, and factors that enhanced or constrained knowledge dissemination.

3.4.3 Data analysis and coding

Using grounded theory—in which theory emerges from data (Strauss & Corbin, 1990), I adopted Gioia’s method to identify first-order concepts, second-order themes, and aggregate dimensions (Gioia, Corley, & Hamilton, 2013). I followed four steps in analysing and interpreting the data.

Open-coding. The first-order coding involved using open-coding approach (Strauss & Corbin, 1990). I began this step by reviewing interview transcripts; looking for “words, lines, or passages that represented a fundamental idea or concept” (Patvardhan, Gioia, & Hamilton, 2015, p. 411). Next, where possible, I faithfully applied “in vivo” codes (Glaser & Strauss, 1967), that is, terms used by informants (Gioia et al., 2013). In other instances where in vivo codes were not available, I used other descriptive terms as close as possible to informants’
interpretation of reality. To reduce the number of first-order concepts, I went through an iterative process of identifying first-order concepts, looking for terms or phrases that were similar in meaning e.g., “listening to recipients”, “taking recipients’ feedback”, “consulting recipients”, and “involving recipients”. To reduce the number of first-order concepts, I selected those terms or phrases that captured deeper nuances relating the phenomenon, and ones that were more prevalent among disseminating and recipient teams. I read and re-read the identified phrases and selected the phrase—in this instance “involving recipients” as a representative to others mentioned. I followed a similar procedure in terms of reducing other first-order concepts. Through an iterative process, I generated 44 first-order concepts.

Second-order themes. For the second-order analysis, I used axial coding (Strauss & Corbin, 1990) whereby I integrated first-order concepts to form a higher-level theme by looking at similarities and differences among them (Gioia et al., 2013; Neuman, 2011). For instance, when comparing the first order concept—“involving recipients”, I identified a close linkage with another two first-order concepts—“making recipients a part of the project”, and “appreciating each other”. By comparing similarities among these three concepts, I consolidated them into a higher-level theme that I call “perspective taking”. By iteratively interpreting and comparing the 44 first-order concepts, I aggregated them into 15 second-order themes.

Aggregate dimension. This step formed the third-level of analysis which involved interpreting the second-order themes to generate a concept that could help me in explicating the phenomenon (Gioia et al., 2013). I constructed three aggregate dimensions for team DCAP processes. For instance, in developing the first aggregate dimension of team DCAP, I consolidated two second-order themes—“perspective taking” and “collective sensemaking” to form a higher-order theme that I call “knowledge co-creation”. I followed this process until I was able to construct the data structure (see Figure 1). In addition, I consulted the literature to
deepen my understanding of the phenomenon of knowledge dissemination. I iteratively condensed the data, discarding those that seemed beyond the scope of the study (Miles, Huberman, & Saldaña, 2014). I thoroughly read and re-read the analysis, comparing the emergent themes with the relevant existing literature to consolidate my understanding and knowledge. Figure 1 illustrates the data structure for team DCAP processes (i.e., knowledge co-creation, implementation, and integration).

Process Model. After the data structure was completed, I transformed it from a relatively static form into a more dynamically step-wise processual form through a process research lens (Langley, 1999, 2007; Pettigrew, 1997). For this purpose, I constructed a visual map i.e., process model (see Figure 2), that demonstrated the sequence and iterative inter-relationships of the processes and micro processes (Langley et al., 2013) representing team DCAP.
Figure 1: Data structure for team DCAP processes, enablers and barriers

1st Order Concepts

- Involving recipients (to understand recipients’ needs & get input for technology design)
- Making recipients a part of the project
- Appreciating each other

- Getting everyone on the same page
- Aligning objectives
- Developing artifacts (e.g., drawings, 3D models & prototypes to reach shared understanding)

- Training recipients to be able to understand and use technology
- Use of various training methods (i.e. conference call, hands on training, photographs, videos & presentation slides)
- Training documentation (e.g., user manual)

- Installing technology at recipients’ location
- Refining technology
- Making sure technology is producing (what it was expected to produce

- Understanding recipients’ problems and engaging in troubleshooting
- Resolving issues
- Following up
- Providing support to recipients in a timely manner

- Routine creation (e.g., sustaining knowledge into the system so it becomes daily operation through ongoing disseminating team support & training of recipients)
- Routine disruption (e.g., disseminating & recipient teams rotating or leaving the organisation & poor recipient role handover)

- Learning (e.g., from first implementation, learning locally before implementing overseas)
- Modifying knowledge based on learning from knowledge co-creation with recipients

- Financial value
- Cost benefit

- Subject matter expertise
- Ability
- Confidence

- Breaking down something complex into something simple
- Teaching at different levels (based on recipients’ absorptive capacity

- Ability to build relationship with recipients
- Ability to convince recipients

- Working well with groups
- Connecting with recipients
- Being friends

- Letting people have an open mind
- Take calculated risks

- Complexity
- Abstractness

- Competing priorities
- Heavy workload
- A lack of resourcing

2nd Order Themes

- Perspective taking
- Collective sensemaking
- Recipient training
- Deployment
- Post implementation support
- Routine dynamics
- Learning

Aggregate Dimensions

- Knowledge Co-creation
- Collective sensemaking
- Implementation
- Integration
- Enablers of team DCAP
- Inter-team relationship
- Psychological safety climate
- Barriers of team DCAP
- Knowledge tacitness
- Resource constraints
Figure 2: Team disseminative capacity (DCAP) process model

Knowledge is co-created and ready for dissemination
- Right scope of knowledge identified
- Relevant knowledge co-created
- Needs of recipient team addressed

ITERATIVE PROCESS OF DISSEMINATING: RECIPIENT TEAM PERSPECTIVE TAKING & COLLECTIVE SENSEMAKING
- Involving recipients (to understand recipients' needs & get input for technology design)
- Making recipients part of the project
- Appreciating each other
- Aligning objectives
- Getting everyone on the same page
- Developing artifacts (e.g., drawings, 3D models, & prototypes to reach shared understanding)

KNOWLEDGE CO-CREATION

TRIGGERS
- Disseminating team highlighting an opportunity
- Recipient team looking for solutions for problems
- Capability of disseminating team to clearly communicate knowledge values induces recipients to accept knowledge
- Establishing relationship with recipients facilitates knowledge co-creation

IMPLEMENTATION
- Recipient training
- Deployment
- Post implementation support
- Technology is installed at recipients' location
- Refining technology
- Making sure technology is producing [what it was expected to produce]
- Understanding recipients' problem and engaging in trouble shooting
- Following up with recipients and providing support
- Post implementation issues resolved, knowledge to be integrated into the system

INTEGRATION
- Routine dynamics
- Learning
- Routine creation (sustaining knowledge into the system so it becomes daily operation through ongoing support & recipient training)
- Routine disruption (disseminating & recipient team rotating or leaving the organisation, & poor role handover)
- Applying learnings to enhance routines & improve future technology implementation

LESSONS LEARNT
- Fed into prospective knowledge transfer events

End of Cycle
- Post implementation issues resolved, knowledge to be integrated into the system

Start of Cycle
3.5 Findings

The findings of this study suggest that team DCAP involves three elemental processes—knowledge co-creation, implementation, and integration. Each of these three processes and the corresponding processual steps is detailed in Figure 2. There are primarily two preceding triggers that occur as part of the dissemination process: (1) the disseminating team has developed a technology or knowledge that represents an opportunity for disseminating team, and/or (2) the recipient team is looking for a solution to a problem (Step 1). In either scenario, characteristics of the disseminating team (i.e., content knowledge, teaching, and interpersonal skills) played an important role in terms of communicating the value of the knowledge, and securing recipient buy-in. In particular, the interpersonal skills of the disseminating team determine whether recipients are willing to accept the knowledge. Interpersonal skills were explained in terms of having the ability to engage and build a relationship with recipients, and to convince recipients using salesperson skills.

Use of interpersonal skills is particularly paramount prior to knowledge co-creation process whereby the disseminating team establishes relationship and builds recipient team’s confidence (Step 2). It is this capability of the disseminating team that can determine whether knowledge is accepted by recipients. According to Aggarwal, Castleberry, Ridnour, and Shepherd (2005), the key salesperson skills include empathy and listening skills. Empathy is “the internal reference of another with accuracy, and with emotional components and meanings…as if one were the other person…” (Rogers, 1959, p. 210). In other words, it is the ability of disseminating team to understand recipients’ needs, concerns, and interests and addressing those accordingly that can assist in securing recipient buy-in for knowledge. In addition, informants placed a high emphasis on inter-team relationship. Inter-team relationship was explained in terms of working well with groups, connecting with recipients, and being friends. One of the informants remarked that “people who are good friends are willing to do
things for somebody more than if they don't know them well” [22, Recipient]. In instances where there were hindrances such as a lack of recipients’ motivation to accept knowledge, disseminating teams utilised their established relationship with the recipients to secure their buy-in.

**Knowledge Co-creation.** Findings of this study revealed that the first and most fundamental process in effectively disseminating knowledge is knowledge co-creation (Step 3). Knowledge co-creation can be defined as the collaborative effort of disseminating and recipient teams in terms of creating new knowledge. I found that knowledge co-creation involves *perspective taking* and *collective sensemaking*. Perspective taking has been defined as taking into account others’ views (Boland & Tenkasi, 1995; Mohrman, Gibson, & Mohrman, 2001; Parker & Axtell, 2001) and “merging of self and other” (Davis, Conklin, Smith, & Luce, 1996, p. 714). Appendix C illustrates additional supporting quotes for the second order themes of perspective taking and collective sensemaking.

From the findings of this study, perspective taking refers to the activities of involving recipients, making recipients a part of the project, and appreciating each other. Recipient involvement included an iterative process of consultation, discussion and interaction with recipients, and seeking feedback to ensure that recipients’ needs and views were incorporated into the development of knowledge. For instance, one informant remarked that “*they [sender team] are willing to listen to the site [recipient] perspective on things...because often the technology they [sender team] want to implement might sound really good in theory but we have limitations on the process*” [22, Recipient]. In addition, involvement of recipients was seen to assist in bridging theory with practice—as one informant added “*...it’s a matter of us [recipients] describing the problem accurately and what we’ve tried already and I guess describing other similar situations that we know of where people have tried solutions that may have partially worked or something that they would like to try*” [34, Recipient]. A majority of
informants emphasised that through recipient involvement, disseminating teams can develop a better understanding of the problems for which recipients seek solution. For instance, one informant stated that “…I think we [disseminating and recipient teams] shouldn’t be working in silos where they [disseminating team] are working on a problem that isn’t necessarily real for us [recipient team] or isn’t going to make a difference for us” [29, Recipient].

Recipient involvement also meant that knowledge gets customised, tailored, or adapted to ensure that it meets recipients’ requirements. Furthermore, making recipients a part of the project was understood as the extent to which co-created knowledge belongs to both parties. Therefore, engagement of recipients in the creation of knowledge ensures that their commitment and ownership of technology are secured. For instance, one of the informants remarked that “once the site [recipients] see it as part of what they do, and they know they’ve been involved all the way through in the design and installation of this bit of kit [technology] then you have much better ownership” [16, Sender]. Appreciating each other was explained in terms of empathising with each other and having affinity toward one another. This involved a collective effort of both parties to understand each other’s situation.

Another important aspect of knowledge co-creation is collective sensemaking. Collective sensemaking is generally understood as the process of understanding novel, unforeseen, or ambiguous events (Maitlis & Christianson, 2014; Weick, 1995). As knowledge is distributed among various parties (i.e., disseminating and recipient teams), each with distinct understanding of what is happening and what needs to be done (Weick, Sutcliffe, & Obstfeld, 2005), both parties engage in collective sensemaking. Collective sensemaking involved getting everyone on the same page, aligning objectives, and developing artifacts. Getting everyone on the same page was referred to as “getting agreement” on the technology that gets co-created by having interaction. For instance, one informant remarked, “when we have discussions and questions are raised we can hopefully get the answer sorted out…or agree to a path on how
we’re going to progress forward” [8, Sender]. In addition, any risks that were associated with the technology were communicated to recipients so as to obtain their confidence in the technology. For instance, one member of the disseminating team remarked that “sites [recipients] are always concerned with risk; they don’t want to be the guinea pigs...[and] it was a matter of convincing [them] that the risk was low and that there were easy escapes if things didn’t go to plan” [21, Sender]. Objective alignment was referred to as the joint effort of both parties to ensure that they had common objectives and that both parties were heading to the same direction. Developing artifacts involved building models, 3D models, drawings, and prototypes to enable both disseminating and recipient teams to reach a shared understanding of the technology. Particularly, through building prototypes, the disseminating team ensured that risks associated with technologies were minimised and that knowledge value was enhanced.

**Implementation.** Findings suggest that knowledge co-creation positively influences the implementation process. As explained earlier, through the process of knowledge co-creation, disseminating and recipient teams can collectively scope, and develop relevant knowledge that can be practically used by recipients. Knowledge that is co-created in this fashion can better address recipients’ needs (Step 4). Consequently, when knowledge is co-created, it facilitates the implementation process. For instance, one of the informants remarked that “when you collaborate there’s less room for conflict, and there’s less room for differences of opinions and less room for people to dig their heels” [29, Recipient]. Therefore, due to prior knowledge co-creation, the implementation process can be undertaken more effectively and efficiently. Following knowledge co-creation, the implementation phase comprised recipient training, deployment, and post implementation support (Steps 5-7). Recipient training involved educating and preparing them with necessary knowledge and skills to utilise the technology. Due to previous knowledge co-creation, disseminating teams were able to deliver more
effective training to recipients. This was because of disseminating team’s capability to engage in perspective taking, and tailoring training to suit recipients’ needs, and ACAP. Informants referred to the use of various training methods including conference calls (in instances where recipients worked in geographically dispersed locations), hands-on training (involving physical demonstration), pre-recoded photographs and videos (outlining instructions step-by-step), and presentations. Consistent with findings of Van Boven and Thompson (2003), I also found that hands-on training is more effective than didactic training—that simply relies on explanation of concepts (Mohammed, Ferzandi, & Hamilton, 2010; Van Boven & Thompson, 2003). Provision of codified knowledge e.g., a user manual or a training documentation outlining fundamental operational and maintenance instructions on technology such as “press this button, flick this lever” [23, Recipient] was also considered important. Producing effective training documentation required teaching skills of the disseminating team. When preparing training documentation, every effort needs to be made to succinctly convey the message. For instance, one of the informants observed that:

“...it [written knowledge] has got to have the context of the previous experience to facilitate retake-up and it’s got to be concise and to the point...” [6, Sender].

Another theme relating to teaching skills that emerged includes teaching at different levels. Teaching at different levels implied that recipients in different roles or positions (e.g., operators, technicians, managers) would receive knowledge that was relevant to them. For instance, one of the informants remarked:

“The technology was delivered to different groups at site at different levels. So the operators were given a more simplified, less technical version of the technology. The technical people were given the full description; the managers were given a document [with] a little bit about the technical [stuff] and a lot about the dollars and the benefits, so I think it was disseminated at multiple levels...” [9, Sender].

The ability to teach at different levels can also be associated with the extent to which the disseminating team engaged in perspective taking and collective sensemaking prior to implementation. Due to previous knowledge co-creation, the training capabilities of
disseminating team can be enhanced in the implementation stage. The process of knowledge co-creation allowed disseminating and recipient teams to share learning, and this process in turn facilitated greater understanding of training needs. For instance, one informant remarked:

“...you need to know what your customer [recipient] wants to hear. So if they want to know how do I do this? How much is it going to cost? What benefit am I going to get? That’s what you tell them, you don’t give them 10 pages of technical data that they’re not interested in or don’t understand” [12, Sender].

Previous knowledge co-creation can facilitate the training capabilities of disseminating team as through this process, they can learn about the needs and capabilities of recipients.

Deployment involved installing and refining the technology and ensuring that the technology is producing what it is expected to produce. In other words, this phase involved hands on installation of technology whereby the technology was set up for operation. Deployment was carried out collectively and this process further enhanced the understanding of recipient teams because they were involved in hands on training. Post-implementation support was related to disseminating teams’ willingness and commitment to troubleshoot, resolve issues, follow-up with recipients, and provide support in a timely manner to ensure knowledge is sustained and routinised (step 8). There was a general consensus that the implementation of a new technology can involve dealing with problems. However, identification of problems and finding solutions to them involved a collaborative effort of disseminating and recipient teams which was enhanced by previous knowledge co-creation. For instance, one member of a disseminating team remarked that “we cannot choose to give the technology and forget about it...we worked for six months later with the plant [recipients] to understand what was happening” [1, Sender]. Taken together, the collaborative effort of disseminating and recipient teams in the implementation phase ensures that technology is effectively integrated.

**Integration.** Integration involved managing routine dynamics, and learning (step 9). Routine dynamics involved two states of “routine creation” and “routine disruption”. Routine
creation was referred to as sustaining knowledge into the system so that it is embedded within the recipients’ daily routines. I found that in instances where knowledge was co-created, and the implementation was collaborative, knowledge was effectively integrated within routines. When knowledge was co-created with recipients, the technology was developed in a way that incorporated recipients’ input, and was effectively put into use. In other instance whereby recipients’ perspective was not taken into account (e.g., poor understanding of recipients’ needs), and the implementation was poorly executed (e.g., poor recipient training), the implementation failed and this required disseminating teams to repeat the training. In addition technologies that were well codified (i.e., in the forms of manuals or training guides), were more effectively embedded within the recipients’ daily routines. Feldman and Pentland (2003, p. 96) define an organisational routine as a “repetitive, recognizable pattern of interdependent actions, involving multiple actors.” However, findings of this study revealed that although routines are created, they can be disrupted for two key reasons. These two reasons included (a) movement of recipients i.e., rotating to other parts of the organisation for career progression or leaving the organisation, and (b) poor role handover of the predecessor recipients to their incumbents. For instance, one informant commented “that person [recipient] in that refinery changes every 12-18 months so you need to have systems that sustain through those…some have left the organisation and so the knowledge hasn’t really stuck in that location as its day to day operation” [32, Sender].

The dynamic nature of recipient movement created a disconnect between the incumbent recipient and the technology, particularly, when adequate knowledge is not transferred. As a result of this disruption, the incumbent recipient had a lower level of knowledge, skill, and expertise to operate the technology, and this in turn diminished the technology value. I found that unless a proper role handover is undertaken, embedding knowledge into the organisation’s daily procedures and systems can be at stake. For instance, one informant stated “what should
really happen is the person [recipient] leaving...should do a proper handover with the incumbents and go through them [incumbents] probably in the way that we [disseminating team] went through them originally” [10, Sender]. Not undertaking a role handover meant that localised knowledge gets lost and that there is a need for the disseminating team to engage in more support such as training new recipients to utilise the technology.

As illustrated below, a member of a disseminating team remarked on the need for more sustained support:

“I think that the transition from doing the implementation to a support part of a technology [should be done] better...we deploy it, walk away and go onto the next thing and then it’s not necessarily considered with the customer site what happens next...what happens when it breaks? Who do they ask and that sort of thing” [11, Sender].

Unlike recipients’ roles, disseminating teams—who were the primary knowledge repository in the organisation, were kept in their roles longer. Despite the stability of roles among the disseminating team, knowledge loss among this group was also inevitable due to role change and retirement. For instance, one informant remarked that:

“...the people in the [sender team] who took over from that particular retiree didn’t understand the fundamentals and so we [recipient team] used them as our help chain to help us understand the process but their knowledge was not at the same level as the key technologist who had left” [23, Recipient].

Taken together, routine can be disrupted by the movement of people (both from disseminating and recipient teams), and this in turn can minimise the likelihood of knowledge to be embedded within routines. However, the data suggest that better role handover among outgoing recipients and their incumbents, timely support of the disseminating team in terms of retraining recipients, and maintaining collaborative effort between the disseminating team and recipient team throughout the various phases of knowledge co-creation and implementation is central to integrating knowledge into daily routines, and embedding it for long-term use. Generally speaking, knowledge integration was considered a learning journey for disseminating and recipient teams.
Knowledge co-creation and collaborative implementation were seen by most informants as avenues for learning. In particular, knowledge co-creation and collaborative implementation allowed the disseminating team to capture learning, and subsequently exploit the learning to enhance future implementation. Further, knowledge co-creation and collaborative implementation facilitated the process of integrating new learning—and this led to modification of technology. For instance, one member of the disseminating team remarked:

“…we [disseminating team] learn as we go and there’s more that we can then disseminate out to other [recipient] teams to make them better….We can learn things that we’ll take away to other places as well because our [technologies] aren’t fixed in stone. They can change as we learn new things – our practices change and we modify the way we view things” [7, Sender].

Learning was associated with the overall improvements in prospective implementations. For instance, one informant remarked, “...the learnings that you’ve had over that first implementation period you take with you to the next one so the next one should be shorter and more streamlined” [8FS, Sender]. By drawing on the learning, disseminating teams were able to be more effective and efficient in subsequent implementations (step 10). One of the informants explained how knowledge co-creation has improved based on lessons learnt from poorly implemented technologies whereby co-creation was low. Based on the lessons learnt, one of the informants explained that “there was engagement from all of the stakeholders [disseminating & recipient teams] from the start of the technology” [23, Recipient]. Consequently, technology that was co-created was then successfully implemented. This outcome was seen by most informants as an enabling factor for disseminating teams to implement knowledge to other recipient teams across the organisation. Taken together, knowledge co-creation, and collaborative implementation enhanced learning of disseminating teams and recipient teams. More importantly, lessons that are learnt in this way can permeate across the organisation. Consequently, through the application of learning, disseminating teams can enhance their DCAP, and this can foster knowledge transfer effectiveness.
**Enablers of team DCAP.** Key enablers of team DCAP included knowledge value, disseminating team’s content knowledge, and psychological safety climate. Knowledge value was considered as an enabler for knowledge co-creation, and its subsequent implementation. Informants viewed financial value as the financial and cost benefits that were generated as a result of knowledge implementation. For instance, one of the informants remarked that “a factor that would make it [implementation] easy is if it [technology] actually works and people can see a benefit in doing it” [33, Sender]. I found that recipients are unlikely to accept knowledge that does not lead to financial benefits or cost reductions. By co-creating knowledge, disseminating and recipient teams were able to enhance knowledge value through a joint effort in identifying recipients’ problems, and collectively designing a technology that could practically and operationally meet their needs.

Another enabler of team DCAP was considered as disseminating teams’ strong and solid content knowledge. Informants viewed content knowledge as having subject matter expertise, ability, and confidence. Having fundamental understanding and expertise meant that disseminating teams need to know the “ins and outs” [24FS, Recipient] of the knowledge area they endeavoured to disseminate to recipient teams. A lack of expertise or demonstrating a lack of expertise was viewed to negatively influence reputation. For instance, one informant remarked “…if they [disseminating teams] screw something up then it’s a very hard thing to correct and people will lose confidence and people have a much better memory for the bad things than the good things” [34, Recipient]. However, to complement disseminating teams’ content knowledge, recipients’ operational knowledge was considered equally important. This was because recipients’ experience and knowledge of the day-to-day problems meant that they could co-create with disseminating teams in terms of technology scope and design. For instance, one of the informants remarked that:

“…we [recipients] pretty much provided the operational aspects and the field experience to make the models work…we developed together rather than a technology that we got given
because we had a problem, we pulled the R&D team [sender team] into the problem, we developed our models using the data that we generated and then applied that technology into the refinery” [29, Recipient].

Another enabler of team DCAP is psychological safety climate which was featured in terms of letting people have an open mind and allowing people to take calculated risks. With regard to the former, one of the informants remarked that “[this organisation's] culture I think historically encouraged people to take a fair amount of initiative and not to be too tightly managed and I think that is good for encouraging innovation” [5, Sender]. Regarding the latter, one informant remarked “…what I want is for people to take risks, make mistakes, get it wrong, but take calculated risks, known risks, and be open about the risks beforehand” [16, Sender]. On the contrary, a lack of this mentality was considered to slow knowledge transfer process. For instance, one informant remarked “…we [disseminating team] can be afraid to take risks at times and move very slowly. I think those are things that will mitigate against the rapid transfer and successful deployment of technology” [3, Sender].

Barrier of team DCAP

**Barriers of team DCAP.** Key barriers of team DCAP included tacitness and resource constraints. Tacitness was seen in terms of the complexity and abstractness associated with knowledge, and served as a barrier for knowledge co-creation, and its dissemination. Existing research also suggests that tacitness increases complexity which in turn makes knowledge dissemination difficult (Szulanski et al., 2016). Complexity is characterised in terms of interdependence of various elements of knowledge piece (Ethiraj & Levinthal, 2004; Simon, 1962; Simonin, 1999a; Sorenson, Rivkin, & Fleming, 2006). For instance, I found that knowledge involving complex mathematics or configuration that is esoteric and requires abstract thinking can be difficult for recipients to understand and, by implication, difficult to disseminate. Therefore, transfer of tacit knowledge can be challenging (Kirkman, Mathieu, Cordery, Rosen, & Kukenberger, 2011) unless delivered directly and in a natural manner that
allows individual team members to choose an appropriate communication mode, such as demonstration and discussion (Griffith & Sawyer, 2010). By co-creating knowledge, disseminating and recipient teams were able to reduce some degree of tacitness in design such as developing a technology that was not complex for recipients to use. In instances where knowledge was perceived tacit, teaching skills of disseminating team were considered important. One of the informants saw teaching skills as the ability “to break down something complex or abstract into something that is relatively clearly communicated and structured” [10, Sender].

Another key barrier for team DCAP was resource constraint. The situation of disseminating and the recipient teams was such that both parties experienced a lack of resources. For instance, competing priorities, heavy workload, and a lack of resourcing were challenges that both teams needed to manage. Competing priorities were explained in terms of “having so many commitments” [6, Sender], and “juggling other projects” [19, Recipient]. Workload was explained in terms of increased “volume of work”, and “number of workers being shrunk” [6, Sender]. I found that multiple simultaneous technology implementations placed pressure on both disseminating and recipient teams. As a result of these pressures, disseminating and recipient teams found it difficult to engage in consultation and shared decision making. To understand recipients’ circumstances, co-location (physically working at recipients’ location or vice versa) was considered important to ensure that disseminating teams understand the business and scope of technology to be co-created. In addition to having the richness of face-to-face communication, co-location is valuable for disseminating tacit knowledge and building relationships (Song, Berends, Van Der Bij, & Weggeman, 2007).
3.6 Discussion

The central objective of this study has been to advance the concept of team DCAP by exploring the key underlying processes that contribute to effective knowledge dissemination. Findings show that team DCAP comprises of three distinct processes, with the initial knowledge co-creation between disseminating and recipient teams playing a critical role in subsequent knowledge implementation and integration. I elaborate the theoretical and practical implications of this study’s findings below.

3.6.1 Theoretical implications

This study contributes to team DCAP and the knowledge transfer literature in several ways. First, I extend understanding of team DCAP by incorporating a process perspective (Langley, 1999; Langley et al., 2013; Van de Ven & Poole, 2005). In doing so, I open the “black box” and show that effective team DCAP involves three distinct processes: knowledge co-creation, implementation, and integration. I found that knowledge that is co-created with recipients’ early involvement can be disseminated with higher acceptance by recipients and hence, impacting on subsequent knowledge transfer effectiveness. As a result, I contribute to the existing DCAP and knowledge transfer literatures by highlighting the critical role of “sender-user” co-creation as a key factor. It is important to note although this process is central to an effective knowledge transfer endeavour, it is underestimated in the extant literature. By exploring the micro-processes that underpin knowledge co-creation, I found that knowledge co-creation not only addresses recipients’ needs, but also places recipients’ contributions in terms of their practical knowledge in the spotlight. Knowledge co-creation emphasises on creating a common ground (Bechky, 2003b) and synthesised knowledge with the combined effort of disseminating and recipient teams. Some prior research has highlighted co-creation processes (Bechky, 2003b; Majchrzak, More, & Faraj, 2011), antecedents (Vlaar, van Fenema, & Tiwari, 2008), and outcomes (Mahr, Lievens, & Blazevic, 2014; Nambisan & Baron, 2009).
This study builds on these research findings and extends current knowledge by closely linking knowledge co-creation and knowledge transfer effectiveness.

Second, the study contributes to knowledge co-creation literature by incorporating the perspective taking (Davis, 1983; Davis et al., 1996; Mohrman et al., 2001; Parker & Axtell, 2001) and collective sensemaking (Stigliani & Ravasi, 2012; Weick, 1995) literatures. By integrating perspective taking and collective sensemaking in the team DCAP literature and knowledge transfer literature in general, I emphasise the importance of social spheres as explained in the SECI model—socialisation, externalisation, combination, and internalisation (Nonaka, 1994; Nonaka et al., 1994; Schulze & Hoegl, 2006) among disseminating and recipient teams. Hence, knowledge co-creation process is an effective form of socialising knowledge before it can be effectively disseminated. While perspective taking and collective sensemaking processes can often involve extended episodes of “back and forth” of interactions between disseminating and recipient teams, they can enhance the quality of knowledge that gets co-created. This can in turn fast-track subsequent knowledge implementation and integration processes. More specifically, knowledge co-creation has a positive “spill-over effect” in subsequent knowledge transfer processes and can promote further collaborative undertakings—i.e., “sender-user” implementation and integration.

Third, I incorporate psychological ownership theory (Druskat & Pescosolido, 2002; Pierce, Kostova, & Dirks, 2001; Pierce, Rubenfeld, & Morgan, 1991) within the co-creation literature. A sense of psychological ownership involves “the collective belief that all members were part owners, and that team actions and outcomes were under the team’s authority and responsibility…” (Druskat & Pescosolido, 2002, p. 291). Through a collaborative effort, recipients can feel valued, and can have a better opportunity for influencing the outcome. For instance, recipients’ ground knowledge (i.e., operational knowledge) can be an example of the way in which they can influence the outcome e.g., technology design; hence, in this way, their
psychological ownership can be developed. Pierce et al. (2001) argue that the more individuals invest their effort into a target e.g., in this instance—knowledge co-creation, the higher their psychological ownership for that knowledge will be. Thus, when knowledge is co-created with the joint effort of disseminating and recipient teams, the feeling of “not invented here” or NIH syndrome (Szulanski, 1996) on the part of recipients can be mitigated. Consequently, knowledge can be effectively disseminated when it is co-created with the joint effort of disseminating and recipient teams.

### 3.6.2 Implications for practice

This study makes several contributions to practice. First, as I have shown, effective knowledge dissemination depends in part on whether that knowledge is co-created. While co-creation through interaction and involvement with customers is widely used in product development (Lusch & Webster, 2011; Mahr et al., 2014; Prahalad & Ramaswamy, 2004; Vargo & Lusch, 2004), its importance remains underestimated in knowledge transfer events within organisations. In addition, there is limited understanding of what steps managers and policy makers need to take by sufficing to extant literature relating to DCAP and knowledge transfer. By opening the “black box” in this study, managers have a better understanding of the important processes that are central to effective knowledge dissemination. To this end, managers concerned with knowledge dissemination should facilitate opportunities whereby disseminating teams take recipients’ perspective (Mohrman et al., 2001; Parker & Axtell, 2001) and engage in collective sensemaking (Stigliani & Ravasi, 2012; Weick, 1995) so as to develop synthesised knowledge that can practically meet recipients’ needs. In this setting, knowledge that gets collaboratively designed and developed not only captures recipients’ needs but also builds their commitment in the application and routinisation of knowledge. More importantly, knowledge co-creation can prevent errors in knowledge design and unnecessary costs
associated with subsequent changes or modifications. In addition, when knowledge is co-created, the time that is spent on knowledge implementation, can be minimised.

Second, managers need to identify team members’ characteristics (e.g., interpersonal skills, content knowledge, and teaching skills) and understand the instances that these characteristics can be appropriately applied. For instance, interpersonal skills of disseminating teams are central before the co-creation process commences. Interpersonal skills involve the capability of the disseminating team to develop a relationship with recipients and convince recipients to accept the knowledge. Mathieu et al. (2008) view this process as confidence building which is a form of interpersonal process. Therefore, managers need to identify those members of the disseminating team who have strong interpersonal skills and allow them to engage in the process of confidence building with recipients to build rapport in early interactions between the parties. In this way, both parties can easily from relationships, which can help define problems and opportunities for knowledge dissemination. Additionally, in other instances (e.g., training sessions) that recipients require content knowledge, managers need to select those group members who have strong content knowledge and teaching skills.

Third, knowledge co-creation is a social process requiring close interactions (Cannella & McFadyen, 2016) between members of disseminating and recipient teams. To facilitate the process, managers should introduce rotation schemes that allow both members of disseminating and recipient teams to temporarily share office spaces. By creating opportunities that allow both parties to work together, managers not only foster cooperation behaviours (Levine & Moreland, 1990) among disseminating and recipient teams, but also enable both parties to understand each other’s work demands. This in turn can facilitate perspective taking and collective sensemaking.
3.7 Limitations and directions for future research

This study inevitably has a number of limitations. First, data were collected from a single organisation. Therefore, certain features are likely to be unique to that organisation, and caution should be exercised in generalising the findings. Second, data included retrospective interviews (Langley & Abdallah, 2011), in which informants were asked to reflect on past experiences of knowledge dissemination and reception. Although the use of retrospective interviews was a strength as it allowed informants to make inferences from past transfer events that were effective or ineffective, retrospective assessment involving past recollection can be biased when relying on one individual or party. I minimised this bias by collecting narratives of multiple informants (both from disseminating and recipient teams) to get their perspectives.

The study suggests several promising avenues for future research on team DCAP. First, in order to gain rich process data, future research can study knowledge co-creation in real time through conducting real time interviews, observations, and analysing archival data (Langley & Abdallah, 2011). Second, there is a need for more in-depth case studies of the processes of knowledge co-creation (i.e., perspective taking and collective sensemaking) within disseminating and recipient teams preferably across different industries (e.g., education, manufacturing, service, etc) to help us gain a deeper understanding of the phenomenon. Third and finally, using a process perspective, future research can explore the importance of material artifacts and how they can facilitate consensus building (Stigliani & Ravasi, 2012) between disseminating and recipient teams in the process of knowledge co-creation. For instance, certain types of material artifacts (e.g., drawings, 3D models, prototypes and so on) can contribute to collective sensemaking differently.

3.8 Conclusion

In traditional organisational settings, recipients are considered as the end users of knowledge, who are isolated, passive, and have limited or no say. In these circumstances,
knowledge is developed as a package for “delivery” to recipients. However, in today’s dynamic organisations, there is a need for a shift to our line of thinking by valuing recipients’ practical knowledge.

In essence, knowledge co-creation means that recipient teams are placed at the forefront—their voices are heard and are permitted to influence the outcome. Involvement of recipients ensures that their views are taken into account (Mohrman et al., 2001; Parker & Axtell, 2001) and incorporated into the development of knowledge. A combination of recipient team’s practical—field knowledge and disseminating team’s expert knowledge means that collectively both parties can make better sense of the type of knowledge required in terms of its design and expected outcomes. In this setting, knowledge that is developed captures the mutual interest of both parties, is problem-focused, aligned with recipients’ needs, and is accepted by recipients. Consequently, knowledge that is co-created can more effectively be disseminated and absorbed by recipients. In instances, where knowledge involves tacitness (Erden, von Krogh, & Nonaka, 2008) and complexity (Simon, 1962), the interaction between both parties can facilitate collective sensemaking (Stigliani & Ravasi, 2012; Weick, 1995; Weick et al., 2005). As a result, recipient teams are more receptive to knowledge, as it is co-created rather than being developed without their involvement or engagement. An effective knowledge co-creation is a fundamental vehicle for the generation of organisational value, innovation, and problem solving.
Chapter 4: Knowledge Co-Creation in Teams: Knowledge Diversity, Perspective Taking and Collective Sensemaking
4.1 Foreword

In previous chapter (Chapter 3), I empirically showed that team disseminative capacity (DCAP) constitutes knowledge co-creation, implementation, and integration processes. Knowledge co-creation emerged as a central process to knowledge dissemination effectiveness which involves the processes of perspective taking and collective sensemaking. Drawing insight from this key finding, I aim to explore further how knowledge co-creation unfolds over time. For this reason, I adopt process research wherein I track knowledge co-creation in real-time. By doing so, I empirically show how various stakeholders i.e., senders, recipients, and external contractors, co-create knowledge, and the importance of their diverse knowledge in determining the outcome.
4.2 Abstract

Knowledge co-creation involves the processes of perspective taking and collective sensemaking. I employed a process research lens to investigate how knowledge co-creation processes involving teams unfold over time. The extant literature demonstrates a lack of understanding on knowledge co-creation processes and how they unfold over time. Additionally, in the knowledge transfer literature, little is known about the influence of recipients’ knowledge on the effectiveness of knowledge dissemination. Responding to these gaps, I explored how knowledge co-creation is enacted by teams in a technology transfer project within a large multinational firm in Australia. The project team involved members from a disseminating team, a recipient team, and external contractors responsible for disseminating technical knowledge, operational knowledge, and specialised engineering knowledge respectively. The analysis is based on a total of 37 interviews at the three time intervals (T1, T2, and T3), archival data, direct non-participant observation of project team meetings over 10 months, and survey. The findings revealed that knowledge co-creation crucially involves early stakeholder involvement to gain knowledge diversity, and the iterative processes of perspective taking and collective sensemaking which lead to co-created knowledge. The co-created knowledge in this context reflected attributes of multifacetedness, utility, shared ownership, and enhanced quality (MUSE). Additionally, the study found that enablers of perspective taking and collective sensemaking included psychological safety climate and team structure (formalising meetings and role clarity). Key inhibiting factors included resource constraints, and risks and uncertainties. The study has important implications for theory and practice regarding knowledge co-creation within disseminating and recipient teams, and knowledge transfer effectiveness.

Keywords: knowledge co-creation, perspective taking, collective sensemaking, knowledge diversity
4.3 Introduction

A growing trend in contemporary businesses has been the co-creation of value by organisations with their stakeholders (Sarker, Sarker, & Sahaym, 2012). Co-creation has been defined as the co-production of valuable knowledge with customers that leads to innovative processes (Mahr et al., 2014), and products. Many organisations reap significant benefits by using customers’ knowledge, skills and resources to co-create value (Mahr et al., 2014). Unlike traditional business models where customers play a passive role as recipients of goods or services (Mahr et al., 2014; Prahalad & Ramaswamy, 2004), the knowledge co-creation business model has a customer-centric emphasis which puts customers at the forefront of business (Teece, 2010).

Within organisations, the value of knowledge that is co-created by different organisational groups and stakeholders (e.g., disseminating and recipient teams) is also increasingly recognised, particularly when it comes to ensuring effective intra-organisational knowledge transfer (Fassehi, Soo, Cordery, & Backmann, 2016). While recent attention has been given to the processes by which teams acquire or absorb knowledge (Backmann et al., 2015; Volberda, Foss, & Lyles, 2010), little is known about the processes used by teams to pass on their knowledge to others within the organisation. Furthermore, the idea that valuable new knowledge might be co-created as an outcome of the interactions between teams, as has been found to be the case with interactions between organisations and external customers, has yet to be explored.

Recently, Fassehi et al. (2016) conceptualised knowledge co-creation as a function of processes of perspective taking and collective sensemaking. Perspective taking can be defined as viewing the world through other individuals’ eyes (Batson & Shaw, 1991; Goldstein, Vezich, & Shapiro, 2014; Stotland, 1969), taking into account others’ knowledge (Boland & Tenkasi, 1995; Mohrman et al., 2001; Parker & Axtell, 2001), and “self—other merging”
(Galinsky, Wang, & Ku, 2008, p. 404). When engaging in perspective taking, egocentrism can be overcome (Davis et al., 1996) through recognising others’ needs, interests, expectations, and subsequently adapting one’s behaviour that may be reflective of “self-centrism”. Indeed, when walking in others’ shoes (Goldstein et al., 2014), it is easier to relate to their circumstances, and this is central to understanding their needs. The second process integral to knowledge co-creation is collective sensemaking. Weick (1995) conceptualises sensemaking as a social activity. In other words, “sensemaking is never solitary, because what a person does internally is contingent on others” (Weick, 1995, p. 40). It is “the process through which individuals work to understand novel, unexpected, or confusing events” (Maitlis & Christianson, 2014, p. 58), and retrospectively develop mental models (Weick et al., 2005).

Advancing the field of knowledge co-creation forward, I conducted a longitudinal study to gain in-depth understanding of knowledge co-creation processes within teams. The objective of this research was to explore processes that underpin knowledge co-creation, how these processes unfold within teams, and the context that supports knowledge co-creation. The research questions that guided the study were as follows: (1) what are the team processes that underpin effective knowledge co-creation? (2) how do knowledge co-creation processes within teams unfold over time? (3) what is the enabling context that can support teams in effective knowledge co-creation?

Central to this research is the value of the knowledge diversity that different team members bring to the knowledge co-creation process. Knowledge diversity reflects the broad range of knowledge, skills, and competencies (Rico et al., 2008; Van Knippenberg, De Dreu, & Homan, 2004; Van Knippenberg & Schippers, 2007) of the parties involved in the co-creation process. In the extant literature, little is known about how knowledge co-creation processes among disseminating and recipient team members unfold over time, as well as how their diverse knowledges complement each other in co-creating new knowledge. More
importantly, we lack understanding of how such knowledge diversity impacts on the knowledge that is co-created, i.e., its unique attributes. As a result of these limitations, scholars and practitioners lack understanding of what constitute effective knowledge co-creation processes, how they unfold, and the enablers of such processes.

To address these gaps in the extant literature, this study examines knowledge co-creation through a process research lens. Van de Ven (1992, p. 169) has offered three definitions of a process: (1) a logic that explains causal relationship between dependent and independent variables, (2) a category of concepts or variables that refers to actions of individuals or organisations, and (3) a sequence of events that describes how things change over time. Of the three definitions, Pettigrew (1997) argues that the third definition can best capture the essence of process in action. The process perspective has emerged from process metaphysics that views processes rather than substances as the basic forms of the universe (Schultz, Maguire, Langley, & Tsoukas, 2012). In other words, individuals, organisations and social phenomena can be explained in terms of “ceaseless change, emergence and self-transformation” (Chia & Tsoukas, 2011, p. 285). Thus, incorporating time into organisational research has become increasingly important (Langley et al., 2013; Langley & Tsoukas, 2017).

In the sections that follow, I review the literature on knowledge co-creation. Next, I describe the method for collecting data, and procedures for analysing data. Then, I report the findings followed with a discussion of the key findings in terms of their implications for theory and practice. Finally, I conclude by highlighting the study’s key findings.

4.4 Theoretical background

Co-creation has been investigated in various empirical studies (Bechky, 2003b; Mahr et al., 2014; Majchrzak et al., 2011; Nambisan & Baron, 2009; Vlaar et al., 2008). For instance, using a case study method, Sarker et al. (2012) studied value co-creation in a business to business (B2B) alliance context and identified three co-creation modes, namely: exchange
(sharing resources/competencies to alliance partner), addition (building on alliance’s contributions), and synergistic integration (collaborating with alliance partner to achieve common goal). Majchrzak et al. (2011) explored knowledge differences in three cross-functional teams and found that teams adopted five practices to integrate knowledge that could in turn be co-created. These included voicing fragments (sharing ideas, solutions, assumptions, and defining problems); co-creating the scaffold (visually presenting the knowledge); dialoguing around the scaffold (discussions by team members e.g., raising concerns, asking questions and offering alternative solutions); moving the scaffold (applying solutions to external stakeholders), and sustaining engagement (ongoing interactions with team members in order to maintain their energy, collective effort, and reduce the possibilities of any conflicts) (Majchrzak et al., 2011).

In an ethnographic study, Bechky (2003b) investigated interactions among various occupational groups (i.e., engineers, technicians, and assemblers). Her findings revealed that misunderstandings among the afore-mentioned occupational groups were associated with differences in language, locus of practice, and definition of the product (Bechky, 2003b). Further, she found that a lack of understanding or shared language could be overcome through the transformation of knowledge among the occupational groups, by means of creating boundary objects (Bechky, 2003b). Knowledge transformation involved making sense of how knowledge from other occupational groups fitted within each occupational group’s context (Bechky, 2003b). Boundary objects on the other hand can be represented in the form of a drawing, prototype, or a map which can serve as a language through which individuals can demonstrate their knowledge and understanding (Carlile, 2002, 2004). For instance, in the study by Bechky (2003a), drawings were used by engineers and technicians because the parties were able to represent their knowledge and communicate in this way more clearly. Hence,
confusion during creation of knowledge can be cleared through dialogue and reasoning (Baralou & Tsoukas, 2015; Tsoukas, 2009), and material artifacts (Baralou & Tsoukas, 2015).

Vlaar et al. (2008) present a case study of information systems development project whereby project team members are in geographically remote locations. They found that knowledge and experience differences, task demands, and tasks that are complex, instable, ambiguous and novel lead project teams to engage in acts of sensegiving, sensedemanding, and sensebreaking. Sensegiving is the “process of attempting to influence the sensemaking and meaning construction of others toward a preferred redefinition of organizational reality” (Gioia & Chittipeddi, 1991, p. 442). Sensedemanding on the other hand refers to cross-checking one’s interpretations and perceptions with other teams (Maitlis & Lawrence, 2007), requesting confirmation, asking for clarification and requesting information (Vlaar et al., 2008). In line with this stream of research, Fassehi et al. (2016) also found that knowledge co-creation is a function of perspective taking and collective sensemaking. This view of co-creation emphasises on a collaborative effort of disseminating and recipient teams whereby they draw on each other’s knowledge to enhance its breadth and depth to collectively make sense of a complex phenomenon (Tyre & von Hippel, 1997). Sense-breaking on the other hand is viewed as the process of “destruction or breaking down of meaning” (Pratt, 2000, p. 464) such as providing alternative viewpoints that are radically diverse from others (Vlaar et al., 2008).

Another related stream of research is the influential body of work on knowledge creation by Nonaka and colleagues (Nonaka, 1994; Nonaka et al., 1994; Nonaka & Toyama, 2007; Nonaka, Toyama, & Konno, 2000; Nonaka, von Krogh, & Voelpel, 2006). Nonaka et al. (2006) referred to four stages of knowledge creation processes as follows: socialisation, externalisation, combination, and internalisation (SECI). The socialisation process refers to creating tacit knowledge through interactions such as working in the same work environment, sharing hands on experience and gathering informally at work and outside work (Nonaka,
1994; Nonaka et al., 2000; Schulze & Hoegl, 2006, 2008). Externalisation refers to conversion of tacit knowledge into explicit knowledge (Nonaka et al., 2000). Combination is the process whereby individuals create explicit knowledge from explicit knowledge (Nonaka, 1994) such as “collecting, editing, sorting, and synthesizing existing explicit knowledge” (Schulze & Hoegl, 2006, p. 214). The fourth process—internalisation refers to conversion of explicit knowledge into tacit knowledge (Nonaka, 1994). Internalisation is closely related to learning such as when trainees absorb knowledge by reading training manuals (Nonaka et al., 2000).

Some studies (Dyck, Starke, Mischke, & Mauws, 2005; Sabherwal & Becerra-Fernandez, 2003; Schulze & Hoegl, 2006) that tested the SECI model found positive results in terms of product development across its various phases.

Stigliani and Ravasi (2012) investigated the interplay between conversational and material practices in a design consulting firm. Their study found that conversational practices include (1) noticing and bracketing, (2) articulating, (3) elaborating, and (4) influencing. Noticing and bracketing refers to identifying cues which is a fundamental step in sensemaking. The second practice, articulating, refers to verbally expressing one’s tentative understanding (Stigliani & Ravasi, 2012). Elaboration, on the other hand, is the explanation of understanding whereby linkages are established between tentative understandings (Stigliani & Ravasi, 2012). This form of sensemaking is referred to as future-oriented sensemaking, whereby the future is invented through imagining, negotiating, talking, and making commitments (Gephart, Topal, & Zhang, 2010). For instance, Gioia and Chittipeddi (1991) adopted future-oriented sensemaking in studying organisational change and restructuring. Another form of sensemaking is retrospective or Weickian perspective on sensemaking (Gephart et al., 2010; Weick et al., 2005) which focuses on the reflection of past events (Weick, 1995). For instance, in studying Mann Gulch disaster (Weick, 1993), accounts of reality emerged from retrospective sensemaking. In the context of this study, I adopt a blend of retrospective and future-oriented
sensemaking in my endeavour to investigate knowledge co-creation. Lastly, influence is referred to as a sensegiving process whereby the way in which other team members make sense is influenced by new understanding (Gioia & Chittipeddi, 1991; Stigliani & Ravasi, 2012).

As mentioned earlier, the study of knowledge co-creation processes in management and organisational contexts is considerably under-developed. In particular, extant research has not investigated the interplay between knowledge co-creation and knowledge transfer effectiveness. An exception is the study by Fassehi et al. (2016) which highlights the importance of knowledge co-creation for subsequent knowledge transfer success. In this study, I adopt process research to explore how knowledge co-creation processes among disseminating and recipient team members (and external contractors) evolve over time. By adopting a processual approach, I track actions associated with knowledge co-creation into the future – “observing processes in action and wondering what will happen next is a very different experience from sifting through archival traces and second-hand narratives that have become immutable and fixed” (Langley & Tsoukas, 2010a, p. 12).

Applying a process research lens is valuable in this context because it can address how and why questions (Langley et al., 2013), and can capture the sequential and iterative processes of perspective taking and collective sensemaking—which are the fundamental aspects of knowledge co-creation. More importantly, by tracking knowledge co-creation processes, I uncover the final outcome (i.e., co-created knowledge and its key features). Additionally, I explore the myriad roles of various actors i.e., disseminating team, recipient team, and external contractors, in terms of enacting the processes of perspective taking and collective sensemaking, and how these processes influence the outcome. The processes of perspective taking and collective sensemaking can often be iterative, until a concrete and shared understanding is developed. For instance, when recipients’ perspective is taken into account, the new perspective that emerges as a result of this process needs to be cross-checked.
(sensedemanding) with recipients to ensure that the perspective taker e.g., disseminating team, and recipients are on the same page (Mohammed et al., 2010). The idea is that the iterative nature of the processes of perspective taking and collective sensemaking can be tracked using process research.

4.5 Method

4.5.1 Research setting

I investigated knowledge co-creation processes by disseminating and recipient teams (and external contractors) within a large multinational firm operating in the mining and resources industry in Australia. The types of technologies that are developed facilitate mining production. The processes involved in the production and processing of the mining resources are complex and often iterative; hence co-creation of knowledge is necessary to ensure that the type of technology that is developed maximises efficiency and effectiveness in mining production whilst minimising any financial, human, or environmental risks. Specifically, the technology that I studied was a full-scale prototype meaning that the technology was new to the organisation and industry. Hence, co-creation was crucial to the success of the project.

The development and dissemination of new technical knowledge to other units within the organisation was the primary function of a team of engineers referred to as the R&D team. In this study I refer to the R&D team as the disseminating team, and to the team targeted to receive that new technical knowledge as the recipient team. The recipients’ role involved sharing practical knowledge that could increase the relevance and usefulness of the technology. External contractors had specialised engineering knowledge whose primary role involved engineering and designing the technology. Although the three parties had distinct roles, they collaborated together throughout the design phases. The project team comprising three parties i.e., disseminating team, recipient team, and external contractors, undertook a series of steps in
developing the technology including feasibility study, preliminary design, detailed design, and execution phases. Each of these phases is explained as follows:

**Feasibility study phase.** This phase which involved conducting feasibility studies, and formulating a business case (including cost estimations) commenced in March 2016 and completed in July 2016. During this phase, disseminating and recipient teams collectively agreed on a location for the new technology.

**Preliminary design phase.** This phase commenced in July 2016 and completed in November 2016. The first few weeks of this phase involved an extension of discussions that had occurred in the feasibility study phase and undertaking additional ground work, which primarily concentrated on transferring learning from previous implementations (e.g., design of technology) as well as verifying business case benefits. The regular project meetings commenced in August 2016. A week later, the researcher commenced observation of weekly project meetings. A key outcome of the preliminary design phase was a written document (i.e., preferred solution agreement (PSA)) which encompassed all deliverables and requirements that needed to be delivered by the project as a whole.

**Detailed design phase.** This phase, which commenced in November 2016 and completed in February 2017, involved basic engineering and design work. During this phase, key reviews were undertaken including project environment, health and safety review (PEHSR), design review, and HAZOP (hazard and operability) reviews. These reviews collectively served as risk mitigation mechanisms. To ensure that the scope and design of technology was accurately engineered, 3D models were generated by external contractors and these were reviewed on regular basis. Throughout the detailed design phase, modifications were made to the technology design in order to accommodate the emergent operational needs of the recipient team.
**Execution phase:** The commencement date of this phase was March 2017. Key activities that occurred during this phase (until the last day of project observation in June 2017) included detailed design and engineering work, and procurement. Procurement involved awarding contracts to external suppliers and purchasing equipment for the physical construction of the technology.

**Sample and data collection procedures**

I employed a process research lens to investigate processes that represent knowledge co-creation, how these processes unfold, and under what conditions they can be fostered. As detailed earlier, I tracked the progression of knowledge co-creation in various phases of the project. Unlike variance approaches, process research places a high emphasis on sequence and ordering (Langley, 1999; Langley & Truax, 1994; Langley & Tsoukas, 2010a; Van de Ven & Poole, 1995). It is through the progression of key processes that new knowledge can emerge. Therefore, my objective is to plunge deeply into these processes (Langley, 1999) that are central to knowledge co-creation between disseminating and recipient teams.

Data collection was carried out using semi-structured interviews (the primary data collection source) at three time intervals, real time non-participant observation of project meetings, ad hoc project reviews, document analysis i.e., meeting minutes, and other strategic organisational documents, and survey. Using a combination of data sources assisted me in triangulating the findings (Jick, 1979). I used purposeful sampling in recruiting interview informants (see Table 1 for details of data sources).

**Table 1: Data sources**

<table>
<thead>
<tr>
<th>Data sources</th>
<th>Descriptions</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interview</td>
<td>37 semi-structured interviews (Face-to-face)</td>
<td>May 2016 to Nov 2016</td>
<td>June 2017</td>
<td>February to March 2018</td>
</tr>
<tr>
<td>Meeting minutes</td>
<td>35 weekly project meetings (1 Sept 2016 to 8 June 2017)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Non-participant observations</td>
<td>36 meetings (1 Sept 2016 to 8 June 2017)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Survey</td>
<td>27 meetings (3 Nov 2016 to 8 June 2017)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Strategic archival data</td>
<td>Stage gate process, design phases, technology implementation criteria, &amp; meeting observation notes</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
**Semi-structured interviews.** Key informants were nominated by the researcher’s three key contact personnel who were knowledgeable about the project that was selected for study at the organisation. The contact persons were senior managers who held a strategic role in the organisation in terms of knowledge transfer and knowledge creation activities. Among the informants, the average tenure at the organisation is 15 years, and the average tenure at their current position in the project is 3.19 years. This indicates that the informants had a good level of understanding relating to knowledge transfer and knowledge creation.

**Figure 3: Interview timeline**

A total of 37 interviews (see Appendix D for list of the interviewees) were conducted at three time intervals (T1, T2, and T3). As depicted in Figure 3, at T1 (May-Nov 2016), 17 interviews were conducted. Of these 17 interviews, seven were conducted with focal project team members, and eight with key informants (i.e., senior management). Two follow-up interviews were conducted with disseminating team leader and a member of recipient team to explore key themes that emerged during early phases of knowledge co-creation. At T1, interview questions (see Appendix E for interview protocols) were generally broad, and focused on how knowledge co-creation evolved in general, and the roles of the parties (i.e.,
members of disseminating team, recipient team, and external contractors) in influencing the knowledge co-creation process. At T2 (June 2017), 11 interviews were conducted with focal team members attending weekly project meetings. The questions at T2 were based on the themes generated from the analysis of T1 interviews and observation data and were more specific in which informants were asked to provide examples based on identified themes, and reflect on the identified themes underlying their view of living in reality. Finally, at T3 (February-March 2018), nine interviews were conducted with focal team members involved in the execution phase of the technology. The underlying reason for conducting the final round of interviews was to explore the outcome i.e., co-created knowledge, and how the processes undertaken by three stakeholders i.e., disseminating team, recipient team, and external contractors influenced the outcome.

Each interview lasted approximately 45 to 60 minutes. All interviews were audio-taped and transcribed verbatim. Interview questions primarily concentrated on team processes that contributed to knowledge co-creation, factors that enhanced or inhibited knowledge co-creation, and the context which supported knowledge co-creation. I also used probing questions to gain deeper understanding into informants’ line of thinking (Miles et al., 2014).

**Observation.** “There is nothing quite like being there in real time” (Langley & Tsoukas, 2010a, p. 12). Observation involved attending weekly project meetings, and other major reviews relating to the project. In the meetings, the researcher primarily observed team processes, e.g., key decisions that were made, and diverse knowledge that was shared. Any questions that arose in the researcher’s mind during meetings were investigated by seeking a briefing from the organisation’s key contact person after the meeting. In addition, a meeting observation protocol was developed, and adapted from Bales (1950). The meeting observation protocol prompted the researcher to observe the structure of meeting, and the way it was run. Extensive notes were taken including verbatim quotes. Attending the first four weeks allowed
the researcher to gain contextual understanding and common trend in the room. This understanding then allowed the researcher to refine the observation protocol by concentrating on knowledge diversity of the parties involved.

The first few meetings were not audio-taped. However, as the participants became comfortable with the researcher’s presence, almost all weekly meetings (except a few that were not audio-taped due to logistical reasons) were audio-recorded to ensure reliability of meeting observation data and to aid the researcher’s notetaking. The recordings were kept with the organisation’s key contact person for confidentiality reasons, and the recordings were made accessible to researcher for transcription at the organisation. However, the transcriptions were allowed to be taken away and are incorporated in this chapter (when relevant).

Meeting attendees were re-assured of the confidentiality of the data that were collected. The researcher asked the organisation’s key contact person to provide re-assurance of confidentiality of the data (notes taken during meeting) on the researcher’s behalf such as aggregating the data, safely securing the data on the university’s password protected computer, and destroying the data upon the completion of the research project. In addition to the weekly meetings, the researcher observed some key reviews i.e., project environment, health and safety review (PEHSR), HAZOP reviews, design review, and operational readiness meetings (meetings that focused on addressing recipients’ requirements during technology implementation e.g., training documents and maintenance manuals). For instance, in PEHSR, “what if”—counterfactual questions (Griffin, 1993) were asked. Similarly, in HAZOP and design reviews, a standard template that contained a set of “what if” and “what could happen” types of questions were asked. Posing of these questions had important implications for the project team because some course of actions i.e., preventative measures were put in place to minimise the impact of any risk should it occur in future.
Meeting survey. For 27 weeks, a short six-item survey was administered to project team members present at each weekly meeting. Two of the six items were on perspective taking i.e., (1) during the meeting, attendees made an attempt to see things from each other’s point of view, and (2) today’s meeting was an opportunity for attendees to make our concerns known to each other. Item one was adapted from Davis (1980) and Mohrman et al. (2001). Item two was adapted from Mohrman et al. (2001). Three items were on collective sensemaking i.e., (3) during the meeting, it was easy for attendees to make sense of what each member had to say; (4) today’s meeting was an opportunity for attendees to ask questions to ensure everyone is on the same page; and (5) take away messages/action items from the meeting were clear. Items three and four were developed based on the observation of the first few meetings and interview data. Item five was adapted from Clark (1998) as well as based on interview and observation data. Item six assessed the overall satisfaction with how the project was progressing. This item was developed to capture the overall satisfaction or dissatisfaction of attendees from the project’s progress. Respondents used a 5-point Likert type response scale (1=strong disagree to 5=strongly agree).

Archival data. Archival data included weekly meeting minutes, meeting observation notes, and other strategic company documents (i.e., stage gate processes, design phases, and technology implementation criteria). Meeting minutes allowed me to track each action that was discussed during the meeting, and how they evolved over time. My personal notes during the meeting further complemented my analysis in terms of taking account of activities that were not recorded in minutes (e.g., how team members communicated during the meetings, and the tools they used that facilitated effective meetings). The strategic company documents provided a high-level understanding of the overarching processes and practices that were adopted in terms of knowledge co-creation. Collectively, the archival data enriched my data by giving me
historical understanding of processes and activities that were valued by the project and the organisation as a whole.

4.5.2 Data analysis

I analysed the transcribed interview data using a grounded theory approach (Gioia et al., 2013; Strauss & Corbin, 1990). I followed Gioia et al.’s method (Gioia et al., 2013) in developing first-order concepts, second-order themes, and aggregate dimensions (as illustrated in Figure 4).

In developing first-order concepts, I used “in vivo” codes (Glaser & Strauss, 1967). In other words, I adopted informants’ exact terms where possible. I assigned researcher-centred terms where in vivo codes were not available. I then engaged in multiple levels of sensemaking to combine these first-order concepts into second-order themes (Gioia et al., 2013) or axial coding “wherein I searched for relationships between and among these categories, which facilitated assembling them into higher-themes” (Corley & Gioia, 2004, p. 183). Next, I further compared these themes until I could form the core categories or aggregate dimensions explicating elements of the model (Langley & Abdallah, 2011). I combined all first-order concepts, second-order themes, and aggregate dimensions to construct the data structure (see Figure 4. Appendix F provides additional quotations illustrating each theme that emerged in this study.
4.6 Findings

The central objective of this study was to unpack how knowledge co-creation unfolds in a natural setting. I present the findings as follows. First, I explain the sequence of a series of processes that represent knowledge co-creation. Then, I highlight the enabling context that supports knowledge co-creation processes followed by knowledge co-creation outcomes.

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### Figure 4: Data structure

<table>
<thead>
<tr>
<th>1st Order Concepts</th>
<th>2nd Order Themes</th>
<th>Aggregate Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Main technical source of knowledge</td>
<td>Disseminating team: Strategic/technical knowledge</td>
<td>Knowledge diversity</td>
</tr>
<tr>
<td>• Bridge the gap between theory and practice</td>
<td>Recipient team: Operational knowledge</td>
<td></td>
</tr>
<tr>
<td>• Define problems to a finer point</td>
<td>External contractors: Specialised knowledge</td>
<td></td>
</tr>
<tr>
<td>• Provide operational guidance</td>
<td>Listening to each other</td>
<td>Perspective taking</td>
</tr>
<tr>
<td>• Critique ideas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Engineering</td>
<td></td>
<td></td>
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<tr>
<td>• Designing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• My opinion was valued</td>
<td></td>
<td></td>
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<tr>
<td>• Allowing everyone to raise concerns</td>
<td></td>
<td></td>
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<tr>
<td>• Giving a realistic timeline</td>
<td></td>
<td></td>
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<tr>
<td>• Understanding workload</td>
<td></td>
<td></td>
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<tr>
<td>• Having shared objectives in terms of deliverables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Being aligned in achieving common goals</td>
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<td></td>
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<tr>
<td>• 3D models</td>
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<td></td>
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<tr>
<td>• Isometrics</td>
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<tr>
<td>• Seeking agreement</td>
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<tr>
<td>• Sign off from relevant people</td>
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<td></td>
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<tr>
<td>• Having open dialogue</td>
<td></td>
<td></td>
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<tr>
<td>• Expressing oneself without any fear of embarrassment</td>
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<td></td>
</tr>
<tr>
<td>• Not having senior people (e.g., immediate supervisors) in the room</td>
<td></td>
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<tr>
<td>• Not shutting people down</td>
<td></td>
<td></td>
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<tr>
<td>• A bit of banter to lighten the mood</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Preparation work [before meeting]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Minuting meetings</td>
<td></td>
<td></td>
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<tr>
<td>• Everyone understood what their role was</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Having the right people in the right roles</td>
<td></td>
<td></td>
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<tr>
<td>• Everything to be low risk and proven</td>
<td></td>
<td></td>
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<tr>
<td>• No framework within the management to accept risk</td>
<td></td>
<td></td>
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<tr>
<td>• Not knowing everything about the technology</td>
<td></td>
<td></td>
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<tr>
<td>• Knowledge tacitness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Having contributions from different people and disciplines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Integrating technical and design knowledge with ground knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• User friendly and ergonomically suitable knowledge</td>
<td></td>
<td></td>
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<tr>
<td>• A sense of ownership</td>
<td></td>
<td></td>
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<tr>
<td>• Being accountable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• The more input, the more diverse the perspectives, the better the quality of technology</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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4.6 Findings

The central objective of this study was to unpack how knowledge co-creation unfolds in a natural setting. I present the findings as follows. First, I explain the sequence of a series of processes that represent knowledge co-creation. Then, I highlight the enabling context that supports knowledge co-creation processes followed by knowledge co-creation outcomes.
detail the sequence of the knowledge co-creation processes in Figure 5. The number in the bracket e.g., 1SRI, 10FRI and so on, is used for identification purposes only; and the words ‘sender’, ‘recipient’ and ‘external contractor’ distinguish the party the informants represented.

**Early stakeholder involvement.** This was the first process of knowledge co-creation that emphasised engaging various parties (i.e., disseminating team, recipient team, and external contractors) with their distinct roles to provide input. One of the informants stated that:

“The fact that you have the variety and diversity of roles contributing to the project in their areas of expertise is what enhances co-creation and people’s varying level of experience will sometimes mean that they contribute only in their own area or maybe in many areas depending on the level of expertise that they have” [4, Sender].

Timing of involvement was considered central to the parties’ capability to co-create knowledge. For instance, one of the informants remarked that “they’ve got to be engaged at the right time otherwise their opportunity to influence is really limited” [5, External Contractor].
Figure 5: A process model of knowledge co-creation

**IN INVOLVING THE RIGHT STAKEHOLDERS EARLY**

- **Knowledge Diversity**
  - **Sender Team**
    - Strategic/Technical Knowledge (i.e., bridge the gap b/w theory & practice)
  - **Recipient Team**
    - Operational Knowledge (i.e., define problems, critique ideas)
  - **External Contractors**
    - Specialised Knowledge (i.e., designing & engineering)

**KNOWLEDGE CO-CREATION**

- **Perspective Taking**
  - Listening to each other
  - Empathising

- **Collective Sensemaking**
  - Aligning objectives
  - Utilising material artifacts
  - Shared decision making

**Barriers**
- Risks & uncertainties

**Enablers**
- Psychological safety climate
- Meeting formalisation
- Role clarity

**CO-CREATED KNOWLEDGE**
- M Multifacetedness
- U Utility
- S Shared ownership
- E Enhanced quality

**Figure 5:** A process model of knowledge co-creation
Knowledge diversity. As mentioned earlier, the process of knowledge co-creation was undertaken by having a mix of parties (i.e., disseminating team, recipient team, and external contractors with different roles) in the room with distinct, yet complementary knowledge, skills, and expertise. For instance, a member of the disseminating team contributed from a technical knowledge perspective and this involved sharing of chemistry knowledge associated with the technology, and ensuring that the strategic aim of technology was maintained.

On the other hand, recipients’ knowledge concentrated on utility, operability and maintainability of technology. Their knowledge contributed toward “[defining] problem to a finer point” [12, Recipient], and “bringing practicality to the outcome” [12, Recipient]. Additionally, the presence of external contractors brought niche knowledge resources in terms of engineering and designing. The capability of the external contractors to engage in knowledge co-creation was relatively limited to addressing design criteria, and contractual agreements associated with engineering and designing the technology. Despite this limitation, their involvement in the weekly meetings provided fresh eyes to the rest of the project team members in terms of problem solving.

Perspective taking and collective sensemaking. Knowledge co-creation emerged as a function of the processes of perspective taking and collective sensemaking. Perspective taking was explained in terms of listening to each other, and empathising. Listening to each other was featured in terms of valuing opinions, and allowing everyone to raise concerns. For instance, one member of the recipient team remarked that “I think everyone was listened to and everyone did have their say and their ability to talk these things through so yes it definitely helped” [1, Recipient]. As mentioned earlier, recipients provided operational guidance. Any issues that concerned them, were raised, and taken into account.

Empathising was explained in terms of giving a realistic timeline, and understanding workload. Depending on the workload of each project team member, the project team leader
would ask the timeline that was practically doable for each team member. For instance, during each weekly meeting, by hearing the concerns of project team members, the project team leader would adjust the completion dates of the tasks if they did not delay other related tasks. However, in some instances, a lack of empathy was demonstrated in terms of increased workload which caused work-related stress to the project team. For instance, one member of the recipient team stated that “If there wasn’t the additional pressure being put on to bring this thing online, it probably would have been a more smooth and easy process. That additional pressure to bring things on piecemeal has caused us a lot of grief, a lot of re-work but, yeah, I think that’s just the nature of it due to time pressures” [1, Recipient].

Collective sensemaking was explained in terms of aligning objectives, utilising material artifacts, and shared decision making. Objective alignment was referred to as having shared objectives in terms of deliverables, and being aligned in achieving common goal. Supporting the objective alignment theme, one respondent stated that “I think what is being done is really engaging with the stakeholders very clearly in terms of the objectives and deliverables of the project and making sure that the customers and stakeholders understand what might be generated by the project” [8, Sender]. The use of material artifacts was considered increasingly important in terms of getting everyone on the same page. For instance, one respondent remarked that “you need to have the 3D models to actually be able to run those guys [operators] through exactly what it’s going to look like so that they can then pick up issues that they’re going to have with this [technology design]” [1, Recipient].

Shared decision making was explained in terms of seeking agreement, and sign off from the relevant people. For instance, one informant stated that “it’s getting everyone to that common understanding [and] to a point where they [recipients] can make decisions about what they’re happy to progress forward with from a design perspective” [1, Sender]. In three instances, I observed whereby project team members signed on the drawings to ensure that they
were happy with technology design. On the one side, this process demonstrated shared accountability. On the other hand, this process demonstrated that the project team members collectively engaged in perspective taking and collective sensemaking. For instance, in one of the project meetings, the external contractor asked from a member of the recipient team who represented technology operators to sign, and the recipient commented “I'm happy to sign, but don't hold me accountable” [observation, 16/03/2017].

**Outcome of knowledge co-creation.** By tracking the sequential processes of knowledge co-creation, I found that the co-created knowledge can be described in terms of having four key attributes: (1) **multifacetedness**, (2) **utility**, (3) **shared ownership**, and (4) **enhanced quality**. As depicted in Figure 5, the first attribute relates to multidimensionality of perspectives spanning three aspects of technical and strategic, operational, and design and engineering knowledge for disseminating team, recipient team, and external contractors respectively. For instance, disseminating team’s knowledge focused primarily on the science and chemistry behind the technology. Whereas, recipients’ knowledge contributed toward making the technology operable. For instance, one of the respondents stated that “…people [recipients] are looking at maintainability and operability, e.g., where is it going to drain down to? How am I actually going to run this?” [7, Recipient]. The external contractors contributed their niche engineering knowledge in designing the technology. For instance, one of the respondents remarked that “We’ve got lots of people that work in iron ore and other designs, so I think it was good from a design point of view to have some fresh eyes looking at how things could be done” [8, External Contractor].

The second attribute—**utility** was achieved through integrating technical and design knowledge with recipients’ practical knowledge. This integration led to the development of the form of knowledge that was user friendly and applicable for use by recipients. Recipients’ knowledge and experience were embedded in their day-to-day operation of the business. They
advocated for developing a technology that was easy to operate, whilst minimising any complexity in the design. Hence, the user friendly feature of the technology meant that “there is minimal work for [recipients]” and that the “operators will enjoy operating” [9, Recipient] the technology. Ultimately, recipients’ closeness, and intimate knowledge of the field facilitated the development of a design that was aligned with their day-to-day needs.

*Shared ownership* was featured in terms of having a sense of ownership of the technology. As knowledge co-creation was a collaborative effort, the project team’s input, and participation in the decisions concerning the design were manifestations of shared ownership. For instance, one respondent stated that “if I’ve been part of that [co-creation process] then I have ownership as well and they [disseminating team] don’t need to ask me to do it because I’m already wanting to do it” [10, Sender]. Recipients contributed by offering their valuable operational and field knowledge. Hence, their ownership of the technology was developed by collaborating with the disseminating team, and external contractors. One of the informants stated that “We’re all doing separate but complimentary parts of the project effectively and that’s just, you know, we [disseminating team] could do it [develop the technology] all but then the site [recipient] doesn’t own it” [10, Sender]. Further, the collaborative effort can develop a sense of accountability in team members toward actions and decision taken. This in turn encourages everyone to represent their groups and their interests in the best possible manner.

Finally, the diverse team collectively contributed to co-created knowledge that had *enhanced quality*. Following the completion of the construction phase, focal project team members were interviewed and were asked to reflect on the quality of the finished project. All project team members were satisfied with the end result as one respondent stated that “we’ve finally finished construction, [and] I think it’s a decent product. The challenge we [project team] always had I guess is no one had seen [this technology] before” and that “there were a lot of unknowns” [7, Recipient]. The nature of the technology—being highly tacit, and novel
meant that as a team, and as an organisation, there was an expectation for a potential risk, and in this instance, it was a design-related error that required some rectification. Despite some errors in design (due to the nature of knowledge being tacit and complex, no precedent or prototype to draw lessons from), the collaborative effort of the three parties (disseminating team, recipient team, and external contractors) led to an enhanced outcome. This outcome would not have been achieved if such a collaborative effort did not co-exist. In sum, I shorten these four elements of the co-created knowledge into the acronym “MUSE” to capture multifacetedness, utility, shared ownership, and enhanced quality.

4.6.1 How did perspective taking and collective sensemaking evolve?

I found that perspective taking and collective sensemaking evolved throughout the knowledge co-creation phases. Figure 6 is a temporal model that outlines how knowledge at the various phases (i.e., feasibility study phase, preliminary design phase, detailed design phase, and execution phase) evolved over time. I used the company’s strategic documents and meeting observation notes to demonstrate the temporal progression of knowledge co-creation (see Figure 6) across its various phases using Microsoft Visio. For instance, in the feasibility study phase, disseminating and recipient teams engaged in perspective taking and collective sensemaking to determine the business case benefits of the technology. During the feasibility study phase, perspective taking and collective sensemaking were at the embryonic level. Therefore, managing risks and uncertainties was a key undertaking for the organisation which included organisational risk aversion, a lack of understanding, and risk mitigation. Organisational risk aversion was featured in terms of wanting everything to be low risk and proven, and having no framework within the management to accept risk.

An unwillingness to take risks was associated with a lack of initiative or action that could lead to financial loss (e.g., if technology did not work). For instance, one informant remarked that “there’s a lot of pressure to be 100 per cent accurate in everything we do. We
need to model everything. We need to have everything to the nth degree proven” [13, Recipient]. The process of minimising risks and getting technology to 100 per cent accuracy level was considered a time consuming process. In addition, there was a lack of risk acceptance on the part of recipients in the inception of the project. For instance, one of the recipients remarked that:

“...what has to happen is [higher management] has to get everyone in a room or whatever and communicates to them and say, “Look, this project is something we need to do and if this doesn’t work I will not hold you fully accountable if it doesn’t work because I’ve accepted that there is some risk in it” so there needs to be some acceptance that we’re taking a good risk” [3, Recipient].

However, risk acceptance at the management level gradually permeated across the organisation as the project progressed. In other words, there was a shift toward risk acceptance as one of the informants remarked that “the company has shifted a little bit in its focus of risk acceptance...[hence]...there is a bit more willingness to try things” [7, Recipient]. A key contributing risk factor was a lack of understanding associated with the unproven technology and the highly tacit knowledge associated with it.

The nature of the technology being a full-scale prototype meant that the technology was not implemented before; hence it was not tested in the refinery. Informants viewed that there are aspects of technology that we do not understand. “It’s actually a prototype because we haven’t done it before” [8, Sender], and that “it’s an unknown” [3, Recipient].
Figure 6: Temporal model of knowledge co-creation
Some informants on the part of recipient team demonstrated a lack of confidence and belief in the inception that resources may be wasted if there is a lack of understanding (i.e., both technical and business case). However, gradually, there was more acceptance of technology as some design risks were mitigated through reviews, and tests. The key reviews are highlighted in Figure 6 (i.e., 7*, 8*, 9*, and 13*). The objective of these reviews was to discuss any potential risks associated with the technology as perceived by the various parties, and develop control measures (where relevant). For instances, in terms of developing control measures, some key issues that were discussed in the reviews included exploring potential causes of risks, their consequences, and developing safeguards (strategies to overcomes or minimise the impact of the risks). Additionally, roles and responsibilities of key individuals in mitigating the risks were also assigned in the review meetings.

Additionally, the tacitness of technology was still acknowledged as a challenge as unforeseen issues may surface during the deployment phase of the technology. Knowledge tacitness was viewed in terms of technical complexity such as the chemistry and reactions of various elements involved. Due to the nature of technology, everything is iterative and interconnects with everything else. For instance one informant remarked that “we don’t know how mixing all these different cocktails is actually going to work” [11, Recipient]. Nevertheless, in the feasibility study phase, there was a high level of risk and uncertainty. The project team used their assumptions and informed guesses as the first available proxy in hand for designing the technology. For instance, one of the informants remarked:

“When you’re in concept development and other aspects you don’t know what you don’t know until you know it, so how can you plan it and how can you execute it. So there’s a level of [risk], you know, when you’re inventing of uncertainty” [7, Sender].

However, in the preliminary design phase, the collective understanding relating to technology design gradually increased. The project team used their diverse knowledge to develop a preliminary design relating to the technology. By the end of this phase, the
disseminating and recipient teams collectively generated the preferred solution agreement (PSA)—a written description of the technology that the external contractors could use to engineer and design the technology. In the preliminary design phase, understanding of project team was still at an embryonic level. Therefore, perspective taking and collective sensemaking to an extent were based on assumptions, and prior learning. However, as understanding increased over time through iterations of perspective taking and collective sensemaking, it was gradually codified, and translated into PSA that could be physically designed, and constructed by the external contractors. I will return to the discussion on the iterations of perspective taking and collective sensemaking when I discuss Figure 7. Also, in Figure 6, I have shown survey results from the inception of detailed design phase to execution phase. I used survey data (see Figure 6) to track the interaction of perspective taking and collective sensemaking. With regard to analysing survey data, I took average of the items for every meeting (i.e., 27 meetings), and then plotted the scores on Microsoft Excel as demonstrated in Figure 6. Because the sample size was small (i.e., an average of seven people attended per meeting), further statistical analysis was not undertaken. As demonstrated in Figure 6, the gap between perspective taking and collective sensemaking during the inception of detailed design was wide. However, gradually the gap narrows, and reaches to a state where perspective taking and collective sensemaking from mid-execution phase onward (i.e., May 2017) blend together. This blend demonstrates a shared understanding of the project team associated with the technology design which allowed them in the end to physically construct the technology.

The interaction of perspective taking and collective sensemaking is the heart of knowledge co-creation. Particularly, knowledge that was tacit required input from various parties, and underwent extended iterations of perspective taking and collective sensemaking. Most actions (i.e., tasks associated with engineering, safety, and procurement aspects of the technology) that were assigned to the project team members involved multiple iterations of
perspective taking and collective sensemaking. I used meeting minutes, and observation notes to demonstrate the intertwined and iterative nature of perspective taking and collective sensemaking as depicted in Figure 7. In the interest of saving space in this thesis, I have depicted one action, (i.e., action c) in a visual form (see Figure 7) that demonstrates the iterations of perspective taking and collective sensemaking. I followed a similar process in all actions, and then converted them into arrows as demonstrated in Figure 8.

As shown in Figure 8, actions were categorised into three categories: engineering (e), safety (s), and procurement (p). In total, I extracted 97 actions which consisted of 54, 28, and 15 actions for engineering, procurement, and safety respectively. Actions demonstrated with longer arrows indicate a higher level of perspective taking and collective sensemaking processes. I categorised these actions that required a higher level of perspective taking and collective sensemaking based on multiple rounds of discussion by the parties, and the time that was required for these actions to be completed. Generally speaking, these actions took a relatively longer time to complete as the parties needed to engage in discussion. The width of the arrow demonstrates the level of understanding. In other words, the thicker the arrow, the more concrete the understanding; hence I observed multiple iterations of perspective taking and collective sensemaking which assisted the project team members to be congruent. I observed the concreteness of project team’s understanding when they agreed to physically construct the technology during the execution phase. The arrows are shown in three colours: red, blue, and green which indicate basic understanding, moderate understanding, and high-level understanding respectively. I assigned these different levels based on the company’s archival data (i.e., strategic documents), and my own observation of the meetings throughout the various phases of the project i.e., preliminary design phase, detailed design phase, and execution phase.
**Figure 7: Progression of action c**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>🟥</td>
<td>Action to be completed</td>
</tr>
<tr>
<td>🟢</td>
<td>Action in progress</td>
</tr>
<tr>
<td>💡</td>
<td>Concerns on selecting the type of equipment</td>
</tr>
<tr>
<td>📚</td>
<td>Discussion among sender &amp; recipient teams, &amp; external contractors</td>
</tr>
<tr>
<td>🕵️</td>
<td>Seeking clarification from sender team</td>
</tr>
<tr>
<td>💲</td>
<td>Cost/benefit analysis undertaken</td>
</tr>
<tr>
<td>📂</td>
<td>Quote received from vendor/supplier</td>
</tr>
<tr>
<td>📙</td>
<td>Equipment references received</td>
</tr>
<tr>
<td>🚂</td>
<td>Approval needed by recipient team</td>
</tr>
<tr>
<td>☑️</td>
<td>Action completed</td>
</tr>
</tbody>
</table>

**Legend**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>🗣️</td>
<td>Meeting cancelled</td>
</tr>
<tr>
<td>💡</td>
<td>Feedback by external contractors</td>
</tr>
<tr>
<td>🕵️</td>
<td>Independent check required</td>
</tr>
<tr>
<td>📂</td>
<td>Confirmation needed from vendors/suppliers</td>
</tr>
<tr>
<td>🕰️</td>
<td>Project team to decide between alternatives</td>
</tr>
<tr>
<td>🕰️</td>
<td>Review by sender team</td>
</tr>
<tr>
<td>🕰️</td>
<td>Review by external contractors</td>
</tr>
<tr>
<td>💡</td>
<td>Incorporate comment/feedback</td>
</tr>
</tbody>
</table>
Figure 8: Progression of actions

LEGEND

- p Procurement actions
- s Safety actions
- e Engineering actions

• Arrow demonstrates an increase in number of actions based on progression of understanding (i.e., basic-moderate-high level)
As shown in Figure 8, actions (i.e., engineering, safety, and procurement) during preliminary design phase were relatively exploratory because a considerable amount of effort was dedicated to clarifying tentative understandings (Stigliani & Ravasi, 2012). Each action that was assigned to the project team members was discussed during weekly meetings, and a new course of action would emerge based on group members’ consensus. For instance, a project team member who was assigned an action (e.g., engineering) would report the progress of that action, and would seek project team member’s perspective.

Based on the project team member’s input, the member would then make necessary modifications associated with that action, and then report back during the next meeting (or whenever that action needed to be completed). The interaction between perspective taking and collective sensemaking ensured that (a), project team members’ perspective is taken, and (b), the outcome of project team member’s perspective is fed back to them in the form of a change or improvement in the course of action. This process continued for each action until it was closed. While all actions were executed in parallel, the procurement actions were only undertaken when a concrete design understanding was developed. A concrete design understanding emerged through 3D models (and isometrics), and major design reviews conducted in the detailed design phase and early execution phase as depicted in Figure 6. In addition, the number of actions completed over time increased as collective design understanding increased over time.

**Enabling context of knowledge co-creation.** This included psychological safety climate which was explained in terms of having a sense of equality among team members and agency of effective leadership. Having a sense of equality among team members was featured in terms of having open dialogue, being able to express openly without any fear of embarrassment, and not having senior people (e.g., immediate supervisors) in the room. The environment that is conducive for everyone to ask questions was manifested in that “people
are not too heated” and “the way they speak is not confrontational” (14, External Contractor).

In saying this, people were still able to voice their concerns or disagreements comfortably.

An environment where people can express themselves without a fear of embarrassment was considered central to knowledge sharing and knowledge co-creation. One informant remarked that such an environment can prevail when “you can express your ideas or ask question without fear of judgement” [6, Recipient]. Another informant remarked that “if people feel that they are going to be laughed at or made to feel inferior because they have voiced an opinion, they are going to be more reluctant to participate within the meeting” [2, Recipient].

In addition, another informant remarked that:

“I think you wouldn’t feel psychologically safe if you were intimidated by the opinions of other people or you felt that if they say my idea is wrong that it must have been a stupid question because they know so much more about me that I don’t feel like I’m comfortable challenging their views whereas if everyone sort of sees one another as relatively equal or of an equal understanding people are going to feel more empowered to share their opinions” [5, External Contractor].

A feeling of embarrassment, fear or judgement was considered as a manifestation of a lack of understanding, knowledge and experience. Getting such a feeling was considered to surface when there is a mix of varying capabilities and ranks of higher management within a room. For instance, on informant remarked:

“...if your boss is there you’re a little bit less inclined to ask questions that could be considered to show a lack of knowledge on your part or show a lack of effort or understanding so you’re trying to protect yourself a little bit more...In other meetings it can [be an issue]. I’ve got a few different projects and some of them, people’s Supervisors turn up or multiple levels of Supervisors turn up especially in [x project] it’s quite common to have the Manager, Supervisor and the Group Leader turn up so not just your boss but your boss’ boss is turning up so that can be more of a challenge” [7, Recipient].

Another theme that emerged is agency of effective leadership and this involved not shutting people down, and a bit of banter to lighten the mood. Creating a comfortable environment involved managing input of people by valuing differences in people’s views. For instance one informant remarked:
“...the team as it stands has a pretty good dynamic...and the project leads create a good environment. If someone asks a question they don’t shut them down” [6, Recipient].

In addition, another informant remarked that “they [project leaders] make you feel comfortable. They’re not forcing the issue or trying to bully their way into getting accepted or their point of view accepted” [8, External Contractor]. Hence the type of environment that was developed by project leaders was reflective of a psychologically safe environment where there was no one that “tried to point score” [15, External Contractor]. Accordingly, the project team leader remarked that:

“I try and create an environment where the people feel safe to share and I think the more that they share then the more that those ideas can come to the fore, that you can have the debate. There are no silly ideas. Everything is on the table and then we have the debate and I think the team members feel that way. You would have experienced some ideas that weren’t necessarily good ideas but we still had the discussion and as a team we came to a resolution on it. I think people feel safe enough that they can voice those opinions” [2, Recipient].

Hence, the quotes above collectively suggest that it is through a psychologically safe climate that various stakeholders i.e., disseminating team, recipient team, and external contractors, can openly share knowledge, which is key to effectiveness of knowledge co-creation, and building a cohesive team.

**Team structure.** This included formalising meetings, and role clarity. Formalising meeting was featured in terms of preparation work before meeting, and minuting meetings. All project members were prepared to report on actions that were allocated to them. Minuting meetings involved generating meeting minutes, and sending out meeting minutes after meeting to get alignment. Generating meeting minutes was undertaken on weekly basis during the meeting involving completion of a standard Microsoft Excel spreadsheet that included agenda item, and action i.e., by who, by when, and the status of the action whether completed, not completed, or on hold as shown in Figure 9. For confidentiality reasons, exact details recorded in the meeting minutes are deidentified.
Figure 9: Example of meeting minutes

<table>
<thead>
<tr>
<th>Engineering</th>
<th>Issues / Comments</th>
<th>Action Required</th>
<th>By Who</th>
<th>By When</th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Diagram A</td>
<td>Issue 1a diagram</td>
<td>Henry</td>
<td>26-Aug-16</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>Diagram B</td>
<td>Complete action B</td>
<td>Daniel</td>
<td>2-Sep-16</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Location of technology</td>
<td>Update document, and technology location.</td>
<td>Ryan</td>
<td>30-Sep-16</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Technology (other aspects)</td>
<td>Nominate location closer than abc.</td>
<td>David</td>
<td>30-Sep-16</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Generating meeting minutes with the aid of a projector facilitated perspective taking and collective sensemaking as members were able to “see what was said or what was agreed on” [3, External Contractor]. For instance, one informant remarked on the benefit of minuting meetings:

“…everyone in the room can actually see what you’ve got up there and have consensus or go, “No, that’s not what I understood about Point 2. I thought this was what was going to happen” because again when you’ve got collaboration whether it be across site or different Departments and so on people take different meaning or understanding potentially from what’s been said or what’s been agreed to” [1, Recipient].

The project team leader (i.e., the meeting chairperson) used colour as a tool to place emphasis on the completion of actions. For instance, actions that required urgent attention were labelled in red (as depicted in Figure 9), and this process put an impetus on people to address the assigned action in the earliest possible time. Once meeting was minuted, it was subsequently emailed to project team members. In sum, the practice of running structured meetings, and minuting actions reinforced a sense of accountability and commitment as members who had agreed to action items were followed up in subsequent weekly meetings regarding the progress of the action. The formalised way of conducting meetings with clear agendas ensured that valuable knowledge that was shared, and generated through discussions were recorded in minutes, and were actioned by those who were assigned the tasks. A lack of having a clear agenda would have led to empty talk, and a potential waste of time. Supporting this claim, one informant stated that:

“…that [meeting agenda] impacts bigtime and it keeps you focused. It keeps you on track. As soon as you lose that then people start going off on tangents and your meeting can last twice as long as what you want it to. You always have to have an agenda to work to. You can go off
sometimes. Sometimes you need to but at least you’ve got something to come back to and say, “Right, this is next. This is next” [8, External Contractor].

Lastly, role clarity was referred to as everyone understood what their role was, and having the right people in the right role. The importance of role clarity was observed in terms of having a clear understanding of the tasks that were allocated to project team members, and this facilitated decision making. Additionally, the clarity of role also meant that each project team member’s knowledge was uniquely valued. For instance, one of the respondents remarked:

“When one person speaks in the room we know what direction they’re coming from. I think that’s very clear with this group so with the people that we’ve been involved with yeah, I think it’s been pretty clear which person is involved in what role and how they actually link into the project” (11, Recipient).

4.7 Discussion

In Study 1 (Chapter 3), I found that knowledge co-creation constitutes the processes of perspective taking and collective sensemaking. Building on this important finding, in this study, I explored the processes of perspective taking and collective sensemaking in real-time to gain a richer and more in-depth understanding of how these processes evolve over time. The findings of this study revealed that knowledge co-creation involves two inter-related processes of perspective taking and collective sensemaking. I examined these two processes in a natural setting by drawing on rich field data. Findings of this study hold important theoretical and practical implications.

4.7.1 Theoretical implications

This study contributes more specifically to the knowledge co-creation literature and more broadly to the management and strategy literature on several fronts. The first contribution of the study is incorporating process perspective (Langley, 1999; Langley et al., 2013; Mohr, 1982) into knowledge co-creation literature wherein I uncover the iterative processes of perspective taking and collective sensemaking. Knowledge co-creation process is made of the
elements featuring perspective taking (i.e., listening to each other, and empathising), and collective sensemaking (i.e., aligning objective, utilising material artifacts, and shared decision making). However, at the heart of knowledge co-creation process lies the iterative processes of perspective taking and collective sensemaking (represented by two intertwined arrows as depicted in Figure 5). In the first instance, when perspective is taken, it needs to be incorporated into existing knowledge. Subsequently, the knowledge needs to be fed back to that stakeholder (i.e., the individual team member whose input is taken into account) in the form of a change or modification in existing knowledge or a rationale for not making such modification. The process of feeding back to the stakeholder whose perspective is taken into account promotes sensedemanding which refers to cross-checking interpretations (Maitlis & Christianson, 2014; Vlaar et al., 2008) to ensure that everyone is on the same page (Mohammed et al., 2010). The iterations of perspective taking and collective sensemaking occurred multiple times in most actions (as depicted earlier in Figure 8) to aid project team members gain concrete design understanding. Thus, findings of this study suggest that multiple iterations of perspective taking and collective sensemaking are essential for developing a team mental model (Klimoski & Mohammed, 1994; Mohammed et al., 2010).

As noted in Findings section, in the feasibility study and preliminary design phases, there was a low level of design understanding. Through perspective taking and “exchange of tentative understandings and discussion of possible linkages between them” (Stigliani & Ravasi, 2012, p. 1245), collective sensemaking among disseminating team, recipient team, and external contractors gradually evolved. Tentative design understanding was codified in a written document, and this written document went through multiple rounds of feedback both from disseminating team, recipient team, and external contractors. Subsequently, in the detailed design phase, interpretations from the codified knowledge were transformed into 3D models—a platform for a higher level perspective taking and collective sensemaking processes. In the
words of Weick (1988), people often do not know what the right course of actions are until they take them and see what comes out of them. The 3D model served as a tool for cross-checking (sensedemanding) and this further enhanced perspective taking and collective sensemaking as the project team could visually see their mental model. Hence, the results indicate that it is through multiple iterations of perspective taking and collective sensemaking that team mental model can converge (Levesque, Wilson, & Wholey, 2001). Ultimately, this visualised mental model represented a concrete design understanding that reflected correctness of technology in width, length, position of parts, general layout, and so forth. However, through multiple iterations of perspective taking and collective sensemaking, the 3D model underwent changes to suit recipients’ design needs. The changes were as a result of the iterative processes of perspective taking and collective sensemaking (Jennings & Greenwood, 2003; Weick et al., 2005).

Second, the study contributes to knowledge co-creation literature by bringing in the concept of knowledge diversity (Van Knippenberg et al., 2004; Van Knippenberg & Schippers, 2007) to uncover how the diverse knowledge of disseminating team, recipient team, and external contractors complement each other in co-creating new knowledge. Earlier, I pointed to three types of knowledge: strategic knowledge/technical knowledge, operational knowledge, and specialised engineering knowledge for disseminating team, recipient team, and external contractors respectively. The integration of such dispersed knowledge occurred through the iterative processes of perspective taking and collective sensemaking. The outcome i.e., co-created knowledge, that emerged as a result of the intertwined processes of perspective taking and collective sensemaking had unique attributes of multifacetedness, utility, shared ownership, and enhanced quality (MUSE). Co-created knowledge that has such attributes is more likely to be effectively disseminated and applied. In this study, I underscore the importance of knowledge diversity and how it can be coordinated across diverse groups (Bruns,
specifically in a disseminating-recipient team context to tease out aspects of knowledge that are overlooked in the knowledge co-creation and transfer literatures. Generally speaking, intra-organisational knowledge transfer literature has focused on disseminating team’s knowledge. Whereas, in this study I show that recipients’ operational knowledge is equally important. Hence, there is a need for the integration of knowledge diversity literature into knowledge co-creation literature so as to highlight the role of disseminating and recipient teams’ knowledge. As a result, knowledge co-creation can lead to improved knowledge transfer from disseminating teams to recipient teams.

Third, I incorporate theories of agency (Emirbayer & Mische, 1998) and temporality (Ancona, Okhuysen, & Perlow, 2001; Barkema, Joel, & Mannix, 2002; Poole, 2004) into the knowledge co-creation literature. By bringing in these two theories together, I juxtapose the importance of actors (i.e., involving the right people to co-create knowledge) and temporality (i.e., when the actors are involved). The idea that key stakeholders i.e., disseminating team, recipient team, and external contractors need to be involved to co-create knowledge is discussed earlier. However, the possibility of co-creating knowledge can be limited if the actors are not involved at the right time. Therefore, the notion of temporality (Langley & Tsoukas, 2017)—“when to be involved” points to the role of time. By highlighting the two aspects of actors or agency of the various project team members in terms of their valuable knowledge, and temporality, I underscore that the quality of the processes (i.e., perspective taking and collective sensemaking) depends on the people enacting the processes, and the time they were involved in the processes. Therefore, depending on the level of knowledge that is required, relevant team members need to be involved at the right time (i.e., early) so that the processes of perspective taking and collective sensemaking can generate an enhanced outcome.
4.7.2 Implications for practice

The findings of this study have several important implications for practice. First, in order for disseminating and recipient teams to effectively co-create knowledge, the team should be formed in such a way that key stakeholders are involved and selected early based on their expertise and experience to influence the outcome. Involving the right people early to co-create knowledge not only increases their chances of influencing the outcome, but also allows them to advocate for their interests based on their distinct roles.

Second, knowledge co-creation should be considered as a series of processes, rather than a short-lived episode. To demonstrate this, managers and policy makers can allocate resources whereby disseminating and recipients are able to collectively collaborate in various processes (e.g., feasibility study phase, preliminary design, detailed design phase) before they can undertake detailed engineering and subsequently executing technology implementation (i.e., undertake procurement and physical construction). This collaborative process not only prevents oversight, but also means that disseminating and recipient teams are able to reduce risks, and fix errors in a systematic and sequential approach. Whilst this collaborative process cannot bulletproof errors, but can serve as a systematic mechanism for increasing product and process development success in project teams.

Finally, in order for knowledge co-creation to thrive, there is a need for formalising meetings, and creating an environment where team members feel psychologically safe to express their views. To enhance knowledge co-creation, managers need to select those chair persons to run meetings who have excellent project management skills (Ahsan, Ho, & Khan, 2013) by going through a standard agenda, and generating minutes whereby action is allocated to individuals based on mutual agreement. The point is to illustrate that in this way, individuals are more likely to perform their tasks that are assigned to them. Additionally, knowledge co-creation can often involve debate and disagreements. Managers should create opportunities for
project teams to engage in multidisciplinary collaborations (Vissers & Dankbaar, 2002) whereby project team members’ immediate supervisors are not present in the room. In this way, the project team members are more likely to voice their disagreements. Whereas, if teams comprise of members that involve supervisors and subordinates in the same room, the power distance, and level of knowledge may mean that the sub-ordinate may more likely avoid disagreements or raising concerns. In sum, managers that aim to promote knowledge co-creation need to create a psychologically safe climate whereby members are not punished in anyway. A lack of psychological safety can result in silence by employees (Bienefeld & Grote, 2012) which can impede knowledge sharing and knowledge co-creation. Therefore, organisations need to carefully assess team composition in order to gain an optimal outcome in their knowledge co-creation endeavours.

4.8 Limitations and directions for future research

Despite the rich qualitative investigation into the notion of knowledge co-creation, this study has several limitations. First, sample size for the study was relatively small. However, in a qualitative research, there can be a trade-off between in-depth investigation of a phenomenon, and smaller sample size. To overcome this limitation, I used multiple data sources across time to triangulate (Jick, 1979) the research findings. For instance, a combination of data sources—interviews at three time intervals, live observation, archival data, and survey helped me gain a holistic understanding of knowledge co-creation process across time. Second, the sample size for the survey was rather small (i.e., an average of seven people attended per meeting). Therefore, further statistical analysis was not undertaken. Additionally, the survey administered at the end of each meeting consisted of a small number of items (i.e., a total of six items). The underlying rationale for administering a small scale in a longitudinal study was to overcome time constraints of project team members as they needed to attend other meetings. However, the size of the scale did not compromise the quality of survey data as I cross-checked
the survey items with the organisation’s key contact person prior to administering the survey to ensure that the survey items best capture perspective taking and collective sensemaking.

The third limitation relates to live observation. Whilst, I gained very rich and insightful data, however, a lack of disciplinary and technical knowledge made it challenging for me to understand everything that was discussed in the first few weeks of the project team meetings. To overcome this limitation, I noted key technical terms and phrases that were used during the meetings, and asked from the organisation’s key contact person for clarity. An additional limitation of live observation is the potential for bringing any personal biases into the notion of knowledge co-creation, and the aspects that I identified as important to knowledge co-creation. To overcome the potential for any observed biases, I followed a rigorous data analysis process and used data from multiple sources to triangulate the research findings. Whilst observation was not the main data collection source, it certainly enriched my research findings as it enabled me to “compare my direct observations with the accounts provided to me” (Van Maanen, 1979, p. 543) by project team members through the interview process. Fourth and finally, I collected data from one organisation (in one specific industry i.e., mining). It is possible that the processes are unique to the organisation and its industry. Despite this limitation, I believe lessons learnt from this study can be applied and transferred across other industries where co-creation of knowledge is vital.

This study advances discussions and stimulates new lines of thinking relating to sender-recipient knowledge co-creation. Unlike the conventional assumption whereby recipients are considered as passive users of knowledge, this study showed that recipients are an important source of knowledge. Future research can draw on the findings of this study to investigate how knowledge diversity across different sectors varies, and whether there are any lessons that can be learnt to inform theory and practice. Additionally, future research can explore processes that are undertaken collaboratively (i.e., in collaboration with members of disseminating and
recipient teams) and those are undertaken in isolation (without involvement of recipients) to juxtapose the outcome. Finally, future research can draw on the findings of this study to explore how knowledge co-creation influences the process of knowledge integration. Investigating the role of knowledge co-creation in knowledge integration has two important implications. First, knowledge co-creation can give some insight whether the diverse knowledge that is held at the levels of teams i.e., disseminating team and recipient team, needs to be integrated, before that newly created knowledge can be integrated at the firm level. Second, it is likely that knowledge that is co-created collaboratively, can be meaningfully applied by recipients. It is anticipated that the extension of knowledge co-creation research into knowledge integration can give rich insight into the collaborative endeavour of disseminating and recipient teams, and potential benefits that can be gained through this mechanism.

4.9 Conclusion

In this study, I tracked how knowledge co-creation unfolded in a natural setting using a process research lens. I investigated disseminating-recipient team (and external contractors) knowledge co-creation by delving deep into the iterative processes of perspective taking and collective sensemaking. I found that the interaction between perspective taking and collective is rather intertwined. The iterative processes of perspective taking and collective sensemaking can serve as a systematic mechanism for maximising the likelihood of being right the first time (albeit not always), rather than spending resources for rectifying errors subsequently. Further, I found that diversity in knowledge leads to multiple perspectives. For instance, recipients have operational knowledge, and this form of knowledge resonates with day-to-day operation of technology. Together, this form of knowledge along with the subject matter expertise of disseminating team, and the niche knowledge of external contractors led to an outcome that features multifacetedness, utility, shared ownership, and enhanced quality (MUSE).
Chapter 5: Knowledge Integration in Teams: The Role of Collaborative Agency
5.1 Foreword

In Study 1 (Chapter 3), I conceptualised DCAP in terms of knowledge co-creation, implementation and integration. I found that knowledge co-creation is central to knowledge dissemination effectiveness. In Study 2 (Chapter 4), I specifically focused on knowledge co-creation, and presented findings based on longitudinal process data. Building on Studies 1 and 2, in Study 3 (Chapter 5), I explore how knowledge is effectively integrated. I juxtapose two trajectories that lead to more effective and less effective knowledge integration. The chapter demonstrates that effectiveness of knowledge integration depends on the collaborative effort of disseminating and recipient teams during all the processes.
5.2 Abstract

This study investigates how knowledge is effectively integrated within an organisation’s daily routines. Drawing on data from seven technology transfer case studies in a multinational firm in Australia, I found two trajectories of actions that led to more effective and less effective knowledge integration. Those patterns of actions that led to effective knowledge integration trajectory involved collaborative agency of disseminating and recipient teams in terms of undertaking a series of processes i.e., knowledge co-creation, co-implementation, co-integration, and co-evolution. However, those patterns of actions that led to less effective knowledge integration were undertaken in isolation. The study contributes to knowledge integration and organisational routines literatures by incorporating agency theory, performative perspective of routine, process theory, and trajectory approach. Findings of the study also have important implications for practice.

Key words: knowledge co-creation, co-implementation, co-integration, co-evolution
5.3 Introduction

One of the most significant bodies of work associated with the study of knowledge management over the past two decades has been knowledge integration—that is bringing together diverse knowledge (Barley et al., 2018) that can be meaningfully applied. This level of attention directed toward this stream of research seems to have “emerged from frequent characterization that the bringing together of disparate knowledge is a central mechanism by which organizations can realize strategic benefits” (Barley et al., 2018, p. 283). Across the decades, scholars have noted that these benefits can be realised when knowledge is routinised (Szulanski, 1996, 2000) and embedded within organisational structures (Howard-Grenville, 2005; Sewell, 1992). According to Feldman and Pentland (2003, p. 96), “an organizational routine is a repetitive, recognizable pattern of interdependent actions, involving multiple actors.” Routines are generally considered as sources of stability and inertia (Aroles & McLean, 2016; M. D. Cohen et al., 1996; Feldman & Pentland, 2003; Kremser & Schreyögg, 2016; Yi, Knudsen, & Becker, 2016). The concept of routine stability can be viewed in terms of maintaining and reproducing routines (Feldman, 2003; Nelson & Winter, 1982), and reducing the need for exercising cognitive effort (Feldman & Pentland, 2003; Zbaracki & Bergen, 2010). However, as stabilised structures, routines can engender “inertia, inflexibility, and mindlessness” (Feldman & Pentland, 2003, p. 99) which in turn can reduce an organisation’s capability to adapt (Yi et al., 2016) and innovate.

Recently, however, scholars have begun to shift their views on routines—from being stable to being more dynamic (Feldman & Pentland, 2003; Kremser & Schreyögg, 2016). This dynamic view of routines allows us to understand the importance of agency i.e., specific actions taken by individuals (Feldman & Pentland, 2003) or collectives i.e., teams whose actions (or inaction) can lead to potential change in routines. Empirical studies (D’Adderio, 2008; Howard-Grenville, 2005; Kremser & Schreyögg, 2016) that have explored this shift toward a
more dynamic view of routines suggest that they evolve over time from one state to the other (Feldman, Pentland, D’Adderio, & Lazaric, 2016). As such, “the interrelation of stability and change is central to routine dynamics” (Feldman et al., 2016, p. 508). While the dynamic view of routines is gaining momentum in the literature, it poses a plethora of challenges for organisations in terms of identifying ways in which knowledge can be effectively integrated.

For instance, the extant literature suggests that knowledge embeddedness occurs when it can last over the long term (Argote et al., 2003), and can be secured into an organisation’s memory (Walsh & Ungson, 1991; Weick, 1979). This view is consistent with the premise that routines are stable. However, the dynamic perspective of routine regards change and stability as two interdependent and inseparable (Farjoun, 2010) aspects of the same phenomenon. To help us better understand how stability and change play out in practice, we need to pay close attention to agency which refers to reflecting on the past, imagining the possibilities in future, and accordingly reacting to present conditions (Emirbayer & Mische, 1998), and the role of various actors in performing those routines (Feldman, 2003). More importantly, understanding how routines are created can give insight into how they can be performed, stabilised, changed or reproduced. Despite growing attention that has been given to routines, little is known about how they are created (Dionysiou & Tsoukas, 2013; Parmigiani & Howard-Grenville, 2011). In a recent study, Davies, Frederiksen, Cacciatori, and Hartmann (2018) investigated how routines are created and replicated by looking at two organisational-level actors i.e., strategic and operational. Davies et al. (2018) found that routines are created through four processes: envisioning, experimenting, entrenching, and enacting. However, there is still a need for more understanding of how various organisational actors enact, and evolve routines (Salvato & Rerup, 2011).

Addressing this gap is important because if knowledge integration at the level of the firm is characterised as routinisation of knowledge (Szulanski, 1996), then having an
understanding of the processes (i.e., new knowledge creation, and routine creation), and the roles of actors (e.g., disseminating and recipient teams) in performing these processes, and understanding conditions or events that disrupt routines can shed some light at a more micro level of analysis. As I defined organisational routines earlier, it takes multiple actors to carry out the actions interdependently (Feldman & Pentland, 2003) before routines can be enacted. Therefore, by studying the role of actors (i.e., disseminating and recipient teams), and the processes that they undertake, I provide a more micro-level understanding of knowledge integration. More importantly, the performative perspective of routine i.e., actions that are taken by actors in carrying out routines (Birnholtz, Cohen, & Hoch, 2007) views change as an unquestionable reality of organisations (Feldman & Pentland, 2003). Thus, the influence of actors over routine change raises an intriguing dimension to the study of knowledge integration. This intriguing dimension is about finding a balance that promotes change in routines, while minimising the disruption that may lead to knowledge loss during the change process. Another lack of understanding is regarding knowledge integration at a more micro level i.e., teams. This lack of understanding is critical because a considerable level of social interaction (Hislop, 2003) needs to take place among various actors before knowledge can be effectively integrated into an organisation’s routines.

For instance, in previous studies (Szulanski, 1996, 2000), there has been an implicit assumption that when knowledge is disseminated from senders to recipients, it is taken to be integrated within their routines. However, a study by Fassehi et al. (2016) has suggested that this is not necessarily the case. They found that effectiveness of knowledge integration depends on whether it is co-created, and the effectiveness of the implementation process. Knowledge co-creation involved the processes of perspective taking and collective sensemaking. When teams engage in perspective taking (Mohrman et al., 2001), they are more likely to take into account each other’s needs, and concerns, and this is central to co-creating a technology that
has practical utility. Furthermore, by engaging in collective sensemaking (Maitlis & Christianson, 2014; Stigliani & Ravasi, 2012; Weick et al., 2005), teams are more likely to develop a mental model that is reflective of being on the same page (Mohammed et al., 2010). The importance of knowledge co-creation was primarily observed in terms of placing recipients, their needs and practical knowledge in the spotlight (Fassehi et al., 2016). Once knowledge is co-created, it can increase the relevance and utility of that knowledge, which can in turn lead to effective knowledge integration at the level of the firm (Fassehi et al., 2016). This study builds on Fassehi et al.’s findings by further exploring the role of knowledge co-creation, and other subsequent processes, and how they can facilitate knowledge integration.

The key question that guides this study is “how is knowledge effectively integrated into an organisation’s routines?” The primary objective in this study is to explore trajectories of processes or actions that lead to effective or ineffective knowledge integration. In this way, I bring to the fore the various processes that lead to effective knowledge integration, and those that result in less effective or ineffective knowledge integration. By applying the trajectory approach (Faraj & Xiao, 2006; Symon, Long, & Ellis, 1996), I uncover the sensemaking processes that occur between senders and recipients as they engage in constructing collective meaning, and coordinating their actions (Christianson, 2017). By doing so, I provide a more nuanced understanding of the processes important to effective knowledge integration.

This study makes three main contributions to the literature on knowledge integration and organisational routines. First, building on previous research (Fassehi et al., 2016), this study contributes to a better understanding of how knowledge co-creation can lead to effective knowledge integration. By exploring knowledge co-creation, I show how diverse knowledge of disseminating and recipient teams is brought together that can be effectively integrated into an organisation’s routines. Second, the study contributes to the dynamic perspective of routines by bringing together agency theory (Howard-Grenville, 2005; Latour, 1986), and performative
perspective of routines (Feldman & Pentland, 2003; Feldman et al., 2016). By doing so, I uncover the role of actors i.e., disseminating and recipient teams in all processes (i.e., processes before and following knowledge co-creation), and how they can influence routines to gain a more micro-level understanding.

Third, the study contributes to knowledge integration literature by adopting a trajectory approach (Christianson, 2017; Faraj & Xiao, 2006; Symon et al., 1996). In doing so, I distinguish between processes that lead to more effective and less effective knowledge integration. For instance, the more effective trajectory points to those series of processes that are undertaken collaboratively (i.e., with joint efforts of disseminating and recipient teams). On the other hand, trajectories of actions that lead to ineffective knowledge integration are those that are undertaken in isolation (poor or a lack of collaboration between disseminating and recipient teams). By explicating trajectories of actions that resulted in effective and ineffective knowledge integration, I explore the role of the specific patterns of processes, and actions (or inactions) by disseminating and recipient teams.

The remainder of this chapter is structured as follows. First, I review the broad literature on knowledge integration and organisational routines with a view to highlight the gaps and limitations in the literature. I then describe data collection procedures followed with data analysis. Next, I present findings of the study followed with a discussion of the findings and their implications for theory and practice.

5.4 Theoretical background

Knowledge integration is defined as the process of embedding knowledge into an organisation’s “routines, processes, practices, and norms” (Davenport & Prusak, 1998, p. 5). The importance of knowledge integration has been noted in different contexts including mergers and acquisitions (Makri, Hitt, & Lane, 2010; Zollo & Singh, 2004), alliances (Grant & Baden-Fuller, 2004; Liu & Ravichandran, 2015), and new product development project
teams (Huang & Newell, 2003; Newell, Tansley, & Huang, 2004; Tiwana, 2004). At the team level, knowledge integration occurs through synthesising and combining individually held knowledge to generate new knowledge (Okhuysen & Eisenhardt, 2002; Robert, Dennis, & Ahuja, 2008). In an experimental study, the results of interventions e.g., time management, and questioning others, indicated a positive effect on team knowledge integration (Okhuysen & Eisenhardt, 2002).

Henderson and Clark (1990) viewed organisational knowledge integration as the combination and synthesis of component knowledge (e.g., core elements of a design or concept) to form architectural knowledge. Architectural knowledge is defined as “knowledge about the ways in which the components are integrated and linked together into a coherent whole” (Henderson & Clark, 1990, p. 11). This form of conceptualisation points to the hierarchy in which knowledge resides. For instance, at the bottom of this hierarchy is personal knowledge, while at the top is architectural knowledge (De Boer, Van Den Bosch, & Volberda, 1999). Somewhere in the middle is knowledge that resides in groups or teams. Henderson and Clark (1990) presumed that once architectural knowledge is embedded into an organisation’s routines, it becomes static. However, as I will discuss next, recent dynamic characterisation of routines (Feldman & Pentland, 2003) challenges this assumption.

A key assumption within the knowledge integration literature is that once knowledge is integrated, it becomes part of an organisation’s routine. This conventional definition points to routine as a source of stability. However, as noted earlier, it is well established in the literature that routines are dynamic, and are sources of both stability and change. The notion of routine as a source of stability places emphasis on consistency (Parmigiani & Howard-Grenville, 2011), and persistence (Nelson & Winter, 1982), which manifests in a predictable behaviour. In this sense, organisational routines involve the “mindless repetition of actions that have been established either through evolution or through the conscious design of someone
other than the people participating in the routine” (Feldman, 2003, p. 728). Routines that are well codified can serve as scripts or a “template for behavior” (Feldman & Pentland, 2003, p. 106), which can provide predictive capacity for the tasks that need to be performed (Zbaracki & Bergen, 2010). The repetitive nature of routines can bring about efficiency (Adler, Goldoftas, & Levine, 1999), and form the memory of an organisation (Nelson & Winter, 1982). Organisations remember routines mainly through continuously using them, and this is similar to the idea that individuals remember their skills by constantly applying them (Nelson & Winter, 1982).

Although routines can provide stability, research also shows that following routines can have negative, sometimes disastrous consequences (Gersick & Hackman, 1990). According to Gersick and Hackman (1990), habitual routines do not involve conscious attention, judgement or choices. In contrast, the dynamic perspective on routines emphasises agency (Feldman, 2000). Feldman and Pentland (2003) argued that organisational routines have two dimensions: structure and agency. Structure is the abstract understanding of routines, whereas agency as mentioned earlier concentrates on the actual performance of actions by specific people at particular times and places (Feldman & Pentland, 2003). Thus, agency explains how and why routines change or persist over time (Howard-Grenville, 2005). Understanding the interactions between structure and agency allows us to recognise the potential ways in which organisational routines can be a source of change (Feldman & Pentland, 2003) and stability.

Another related theory to structure and agency is the notion of ostensive and performative aspects of routines. Feldman and Pentland (2003) and Pentland and Feldman (2005) distinguish between ostensive and performative aspects of routines as follows. The ostensive aspect of routine emphasises the abstractness of the patterns of actions, whereas the performative aspect concentrates on the specificity of the actual actions (Pentland & Feldman, 2005). The ostensive and performative aspects of routines (Feldman & Pentland, 2003) have
been derived from Latour’s work on power (Latour, 1986). Latour (1986) argued that power exists in an obscure form (principle), and in practice. He referred to the former power as ostensive and the latter as performative, and Feldman and Pentland (2003) draw on the same conceptual distinction to theorise that routines have both ostensive and performative aspects. While the ostensive aspect of routines has symbolic significance, the performative aspect emphasises the actual actions that take place. Further, Feldman and Pentland (2003) argue that the ostensive aspect of routines should be considered as a guiding principle for the performative aspect. The ostensive aspect changes as the actor evaluates the context. Overall, a recognition of the performative aspect of routines has meant that where researchers previously focused on “repetitive patterns of action, uniformity, and inertia, we are now sensitive to variations, adaptations, and change” (Dionysiou & Tsoukas, 2013, p. 183).

The change associated with routines is primarily seen as a function of learning (Holmqvist, 2004, 2009; Levinthal & March, 1993; Levitt & March, 1988). For instance, learning can occur in different ways such as learning-by-doing involving direct experience (Argote & Miron-Spektor, 2011; Pisano, 1994; von Hippel & Katz, 2002), or vicarious learning (Bresman, 2013) which involves learning from others’ experiences (Levinthal & March, 1993; Levitt & March, 1988). The key point is that once learning occurs, it can influence the extent to which knowledge is integrated. That is, it can pave the path for changes in routines, and open up possibilities for unlearning. Unlearning can occur through giving away old routines that do not generate value (de Holan & Philips, 2004). However, learning does not occur in a vacuum, and requires active participation of various organisational actors to share their learning. According to Tyre and von Hippel (1997, p. 72), “learning is a social process”, and the social context influences what and how organisational members learn. In the context of knowledge integration, little is known about how senders and recipients share their knowledge and collaborate during this process. This lack of understanding can limit the possibility of
understanding the role and impact of senders’ and recipients’ knowledge in the integration process.

In summary, knowledge integration is a complex and multifaceted phenomenon. Whilst organisational knowledge integration is represented in terms of routinisation of knowledge, little is known about the processes that are involved in integrating knowledge held at a more micro level e.g., team-level. This micro-level understanding is important because we can unravel the importance of agency (Emirbayer & Mische, 1998), that is actions taken by disseminating and recipient teams that can explain how and why routines change or persist (Howard-Grenville, 2005). In this way, we can untangle trajectories of actions that are performed collaboratively (or in isolation) that influence knowledge integration. By adopting a process lens (Langley, 1999; Langley et al., 2013), I explore the myriad processes that constitute effective (or ineffective) knowledge integration trajectories. In sum, the key focus of this study is to unravel the significant role of agency, that is, how the different parties i.e., disseminating and recipient teams, perform processes in collaboration (or in isolation) that can influence the effectiveness of knowledge integration. Thus, this study contributes to the field of knowledge integration by providing a more micro-level understanding.

5.5 Method

5.5.1 Sample and data collection procedures

Using a case study research design (Eisenhardt, 1989; Graebner & Eisenhardt, 2004), I adopted an inductive, interpretive approach to explore how knowledge is effectively integrated into an organisation’s routines. The rationale behind using an interpretive approach is that it is more appropriate for understanding a “phenomenon from the experience of those living that phenomenon” (Gehman et al., 2018, p. 294). The organisation in which I conducted this research is a large multinational mining company in Australia. The transfer and application of technologies are integral to the company’s efficiency and effectiveness in mining production.
I used multiple cases i.e., seven technologies, and each case was centred around development, and implementation of a particular technology. The cases varied in terms of the level of knowledge tacitness (or complexity). However, most cases were regarded as relatively tacit, and this further enriched the study as multiple levels of organisational stakeholders i.e., senders and recipients, were involved in the development and transfer of these technologies.

To understand how the various processes unfolded, I adopted a process lens (Langley, 1999; Langley et al., 2013) which focuses on “how and why things emerge, develop, grow, or terminate over time” (Langley, Smallman, Tsoukas, & Van de Ven, 2009, p. 1069). I built my process theorizing by adopting a narrative approach which is commonly known as the sequential ordering of events usually in a chronological order (Czarniawska, 1995). By incorporating perspectives of disseminating and recipient teams associated with the transfer of the same technology (see Appendix G for interview protocol), I was able to deepen my process story. That is, by incorporating perspectives of both parties, I was able to triangulate the results to minimise cognitive biases.

Most importantly, from the narratives of both parties, I was able to identify trajectories of actions that led to effective or ineffective knowledge integration. The trajectory approach is primarily used in the medical field (Plough, 1981; Strauss et al., 1985; Wiener, Strauss, Fagerhaugh, & Suczek, 1979), and is defined as “not only the physiological unfolding of a patient’s disease but the total organization of the work [italics in original] done over that course” (Strauss et al., 1985, p. 8). Beyond medical field, the trajectory approach is also used in management and organisation studies e.g., team dynamics (Faraj & Xiao, 2006; Klein, Ziegert, Knight, & Xiao, 2006), and sensemaking (Christianson, 2017). In the context of this study, I adopt the trajectory approach based on informants’ narratives to identify and categorise a series of actions and processes that are undertaken by various actors i.e., disseminating and recipient teams, which in turn lead to effective and less effective knowledge integration.
For each of the seven cases of technology transfer, I interviewed at least one member of the disseminating team, and one member of the recipient team. Adopting a combination of purposive and snowballing techniques for recruiting informants, I collected a total of 31 narratives from September, 2017 to May, 2018. Of the 31 narratives, five of them were conducted with senior managers to gain a high-level perspective on issues concerning knowledge integration and embeddedness. The remaining 26 narratives were conducted with members of disseminating and recipient teams who were involved in the development and application of the seven technologies. Through narratives which typically involved sharing stories, and rationale for performing or not performing certain processes (Barry & Elmes, 1997; Bruner, 1991), respondents were able to make sense of and reconstruct their lived experiences (Fachin & Langley, 2017). Thus, through these narratives, I was not only able to identify trajectories of actions that occurred before knowledge integration, and how these processes influenced knowledge integration itself, but also the processes that emerged following knowledge integration. The narratives lasted between 45 to 60 minutes. All narratives were audio-taped and transcribed verbatim. Please refer to Appendix H for demographic details of respondents i.e., position, overall experience, number of years in current role, team membership, and their association with technologies.

5.5.2 Data analysis

Data analysis involved applying grounded theory approach (Straus & Corbin, 1998) whereby I followed the three steps of developing first-order concepts, second-order themes, and aggregate dimension (Gehman et al., 2018; Gioia et al., 2013). First-order concepts are informant-centric terms (Van Maanen, 1979), and these included the actual terms, phrases or statements used by informants (or any terms selected by the researcher that captured respondents’ experiences). The process of developing first-order concepts is similar to the notion of open coding by Straus and Corbin (1998). Along the process of developing first-order
concepts, I identified similarities and differences among the first-order concepts, and formed a higher-level grouping—second-order theme (Nag, Corley, & Gioia, 2007). Identifying second-order themes is similar to the notion of axial coding by Straus and Corbin (1998). That is, it involves linking categories i.e., a phenomenon or issue that is significant to respondents, to their sub-categories (Straus & Corbin, 1998). Finally, by assembling the second-order themes, I formed aggregate dimensions to help explain the phenomenon (Gioia et al., 2013). Figure 10 depicts first-order concepts, second-order themes, and aggregate dimension associated with knowledge integration.

**Figure 10: Data structure**

<table>
<thead>
<tr>
<th>1st Order Concepts</th>
<th>2nd Order Themes</th>
<th>Aggregate Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involving recipients &amp; understanding their needs</td>
<td>Perspective taking</td>
<td>Knowledge co-creation</td>
</tr>
<tr>
<td>Getting recipient buy-in by catering for their needs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incorporating recipients’ operational knowledge</td>
<td>Collective sensemaking</td>
<td></td>
</tr>
<tr>
<td>Building confidence in recipients by managing risk associated with technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing training (i.e., one-on-one coaching, PowerPoint presentations, and learning on the job)</td>
<td>Recipient training</td>
<td>Knowledge co-implementation</td>
</tr>
<tr>
<td>Providing learning guides to recipients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintaining post deployment support to solve issues</td>
<td>Post implementation support</td>
<td></td>
</tr>
<tr>
<td>Embedding knowledge into daily routines through standard procedures e.g., daily routine checklists and maintenance checklists</td>
<td>Embedding knowledge into organisational system</td>
<td></td>
</tr>
<tr>
<td>Automation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Documenting knowledge (explicit and tacit)</td>
<td>Embedding knowledge through codification</td>
<td>Knowledge co-integration</td>
</tr>
<tr>
<td>Undertaking in-depth knowledge handover to minimise knowledge loss (due to turnover e.g., rotation, voluntary &amp; involuntary turnover)</td>
<td>Knowledge handover</td>
<td></td>
</tr>
<tr>
<td>Retraining recipients (due to turnover)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Understanding what works &amp; what doesn’t work from previous implementation</td>
<td>Collaborative learning from previous implementation</td>
<td>Knowledge co-evolution</td>
</tr>
<tr>
<td>Refining knowledge based on learning from previous implementation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incorporating recipients’ feedback for knowledge refinement</td>
<td>Recipient-centric change</td>
<td></td>
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<tr>
<td>Simplifying knowledge based on recipients’ feedback</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.6 Findings

5.6.1 Knowledge integration trajectories

From 31 narratives across the seven cases of technology transfer, I have identified a myriad of processes that resulted in effective or less effective knowledge integration. In this study, I refer to technologies as those processes, machines, and instruments that were used to enhance efficiency and effectiveness of mining production for the organisation involved. Additionally, throughout the study, I use technology and knowledge interchangeably. The series of processes that led to effective knowledge integration involved a collaborative effort of disseminating and recipient teams. These processes included knowledge co-creation, co-implementation, co-integration, and co-evolution. On the contrary, the processes that led to less effective (or ineffective) knowledge integration include those processes that lacked collaboration between senders and recipients. The way in which the more effective and less effective processes unfolded based on the narratives are presented below. Figure 11 illustrates two trajectories that led to more effective and less effective knowledge integration. Appendix I outlines representative quotes for more effective knowledge integration trajectory in which knowledge co-creation was considered as central to effective knowledge integration. As demonstrated in Appendix I, Technologies A, B, C, E, and G were more effective. Appendix J outlines representative quotes for less effective knowledge integration which included Technologies C, D, and F. The basis for assessing the effectiveness or ineffectiveness of the technologies was whether they were co-created, and effectively used by recipients.

Knowledge co-creation. A fundamental process that positively influenced knowledge integration is knowledge co-creation. Knowledge co-creation emerged as functions of perspective taking, and collective sensemaking. Perspective taking included involving recipients and understanding their needs, and getting recipient buy-in by addressing their needs. Needs were described in terms of problems, or any concerns that recipients had associated with
technology. Understanding recipients’ problems, and catering for their needs by means of co-creating a technology was considered as key to knowledge integration.

It was understood that incorporating recipients’ practical knowledge can increase the relevance of technology to recipients’ work and operational context. Supporting this argument, one respondent remarked that by involving recipients from early stages of concept development, it brings “intimate refinery [recipient] knowledge and needs to ensure that the technology is going to fit what they want and that linkage is probably 95% of getting it right” [17, Sender]. Additionally, by involving recipients, they can develop a sense of ownership of technology. Hence, when knowledge is co-created, it can address recipients’ needs, can be relevant for use, and give recipients a sense of ownership. In this way, knowledge can be easily embedded into their routines. For instance, one respondent remarked that “bringing those two groups [senders and recipients] together provides the full information that is the foundation for doing the job well but from a more human perspective, people are more engaged by something that they’ve been involved in creating and so creating a team that’s engaged and both for jointly working on it I think creates a sense of excitement from both sides” [30, Sender]. Throughout all the processes, the close link and collaborative effort of disseminating and recipient team was considered key to effective knowledge integration.

Another important aspect of collective sensemaking is building confidence in recipients by managing risk associated with technology. Risk was considered as a financial loss in instances whereby the technologies did not work or did not address recipients’ needs. Recipients generally adopted those technologies that worked. In other words, technologies need to be “proven”, before they can be effectively embedded into recipients’ routines. For instance, one informant remarked that “we’re technologically conservative—we would want to see it implemented somewhere else so somebody else will have had to have taken that risk before” [10, Recipient].
Figure 11: Process model: Effective and less effective knowledge integration trajectories

**Perspective taking**
- Involving recipients & understanding their needs
- Getting recipient buy-in by catering for their needs

**Collective sensemaking**
- Incorporating recipients’ operational knowledge
- Building confidence in recipients by communicating knowledge value and risks

- More effective knowledge integration

- Less effective knowledge integration

**Knowledge co-creation**
- Lack of perspective taking
  - Very little involvement of recipients in development of technology
  - Not hearing or understanding recipients’ concerns

- Lack collective sensemaking
  - Developing technology in isolation of recipients
  - Not seeking recipients’ agreement
  - Increasing recipients’ risk perception by hiding knowledge due to fear of leakage

**Knowledge co-implementation**
- Poor recipient training
  - Lack of recipient understanding of technology due to a lack of training
  - Lack of training documentation to aid with understanding technology

- Lack of post implementation support
  - Lack of timely support to solve issues

- More effective knowledge integration

**Knowledge co-integration**
- Poor knowledge embeddedness through routines
  - Poor embeddedness of knowledge into daily routines through standard procedures e.g., daily routine checklists and maintenance checklists

- Poor knowledge embeddedness through codification
  - Poor documentation of knowledge

- Poor knowledge handover
  - Poor knowledge handover
  - Loss of tacit knowledge because of people movement

- Less effective knowledge integration

**Knowledge co-evolution**
- Relearning
  - Reinventing the wheel

- Resistance to change
  - Being happy with status quo
  - Risk aversion

- Collaborative learning from previous implementation
  - Understanding what works & what doesn’t work from previous implementation
  - Refining knowledge based on learning from previous implementation

- Recipient-centric change
  - Incorporating recipients’ feedback for knowledge refinement
  - Simplifying knowledge based on recipients’ feedback
On the part of disseminating teams, it required a high level of risk communication and awareness until recipients would gain confidence in embracing the technology. However, engaging in perspective taking, and incorporating recipients’ knowledge into the development of knowledge was understood to help in terms of building confidence in recipients and minimising risks associated with technologies. Hence, perspective taking and collective sensemaking demonstrated the collaborative agency of disseminating and recipient teams which in turn represented the effective knowledge integration trajectory.

Some themes (as depicted in Figure 11) also emerged in relation to a lack of knowledge co-creation which in turn led to less effective knowledge integration. For instance, very little (or a lack of) involvement of recipients in the development of technology, and not hearing or understanding recipients’ concerns demonstrated a lack of perspective taking. For instance, one respondent remarked that:

“...a lot of these processes were done in isolation of [recipients] so as a customer who was supposed to run this process, we were given a package, a constructed installation with very few instructions so it’s like getting a – let’s say you’ve got a box of Lego to make a Darth Vader but you haven’t got many instructions to put it together, so we had a few presentations. We had some very sketchy details in terms of how it worked but I’d argue that there was very little involvement of us in trying to develop the technology, design it or run it until right at the very last minute so all of a sudden we were given this process that we had to commission and work and we really didn’t know what it was supposed to do or how it was supposed to work” [16, Recipient].

As stated in the quote above, a technology given to recipients without their involvement in its development is very unlikely to result in effective implementation and integration of knowledge. A lack of perspective taking was also reflective of a lack of collective sensemaking. That is, recipients’ knowledge was not incorporated into the design of technology, and this in turn led to ineffective implementation and integration. For instance, one technology operator remarked that:

“...if I’m running the [technology] and you [sender] come to me and say, “I’ve got this technology that’s going to make the [process] run better. Here it is” and you’ve got to run it, wouldn’t you think that you would come to me and say, “Listen, I’ve got this technology we’re coming up with. What do you think you could add to make it run better?” Wouldn’t you think
that if I’m running it day-to-day that I’d have more input than some guy that sits in an office somewhere else that doesn’t know how to run it but to me that’s just you get the people that actually run it to give you the information” [27, Recipient].

Additionally, in some instances, the concerns related to intellectual property (IP) prevented the disseminating team from sharing all relevant knowledge associated with the technology to recipients. The disseminating team only shared those aspects of knowledge that they believed were more relevant to recipients. In other words, the science behind how technologies were built or how the various parts were integrated (to ensure that they worked) was withheld from recipients. For instance, one member of the disseminating team remarked that:

“...we [disseminating team] couldn’t explain absolutely everything to the nth degree. Initially we weren’t even allowed to show the equation so you can imagine being an Engineer [recipient], “I want to see this. What does this mean and we want to implement something that I can’t even know about?” It makes them wary and they don’t feel like they’re part of it. They are not co-creating it because I’m just hiding this thing in a box so I think initially many people thought it was just a big box. They put something in they get something out. What’s in there? I think now we’ve released a little bit of that and allowed people to see inside the box a bit more so then it’s gotten them, “Okay, I’m part of it now” [4, Sender].

As shown in the quote above, when knowledge is not shared to recipients, this process can raise doubts in recipients which in turn can undermine the value of knowledge and how it can benefit recipients. Supporting this argument, one of the recipients stated that “I think sometimes the R&D team [sender team] can be a bit of a shut shop. It depends on the relationship you have with the R&D team and how actively you pursue that information” [10, Recipient]. The respondent suggested that “I think some of the stuff is top secret or commercially sensitive, so they don’t share it and that’s understandable, so I think there’s a balance there. I think at times though they should share more” [10, Recipient]. By sharing knowledge, it was understood that disseminating and recipient teams could further enhance their collaborative effort. However, the tendency to withhold knowledge from recipients increased recipients’ level of risk perception, and decreased knowledge co-creation. As a result, recipients were unwilling to implement technologies that they had limited knowledge in terms
of their functionality and the potential benefits they could offer to recipients. Hence, withholding knowledge from recipients, and a lack of perspective taking and collective sensemaking demonstrated a lack of collaborative agency. A lack of collaborative agency i.e., actions carried out in isolation (without recipient involvement), represented less effective knowledge integration trajectory.

**Knowledge co-implementation.** Following knowledge co-creation, knowledge was co-implemented which included recipient training, and post implementation support. It was found that disseminating teams were the key knowledge source. They passed on the knowledge to recipients (i.e., engineers) through various means such as running workshops, presentations, and one-on-one hands on coaching. Most engineers (recipients) held a relatively similar technical knowledge base (content knowledge) to the disseminating team (albeit at relatively lower level), and they in turn passed on the knowledge to the technology operators in terms of how to use and maintain the technology. From operators’ perspective, training was considered as a key determinant of effective technology integration. Supporting this argument, one of the recipients stated that “you could have the most advanced technology you want but unless your people understand it, there’s no point having that technology. The more understanding you have from the people that run it, the better the technology is going to run” [27, Recipient].

The development of training guides was also considered key to effective training. Training guides were mainly developed by disseminating teams. For instance, one member of the disseminating team remarked that:

“...we definitely provide degrees of training when we’re doing the implementation and calibration of the project including documentation of the results, and we also have follow up training sessions, conference calls by the community on an as needs basis, so if people are asking for some support then we’ll give training presentations, packages, or tailor information to suit what someone’s asking for” [2, Sender].

However, recipients with a high level of technical knowledge i.e., engineers, were also involved in terms of tailoring them to meet technology operators’ needs. The development of
training guides by the disseminating team was exercised with caution as on the one hand it was considered important in terms of helping them better understand the technology. On the other hand, it posed the risk of IP leakage. For instance one member of the disseminating team remarked that “we [disseminating team] had to develop the training material and secondly we had to figure out who to give it to and how to deliver it because it’s highly confidential so we can’t just say, “Here’s a PowerPoint Presentation. Read it”. No way. We need control of that document” [5, Sender].

Overall, in instances whereby recipients were trained well in terms of operating and maintaining the technology, the implementation was effective. However, when training was poorly undertaken, recipients had a poor understanding in terms of utilising the technology. Some informants pointed that they did not receive adequate training, and had to “learn on the feet” [27TS, Recipient]. Supporting this argument, one of the recipients stated that “when it comes to rolling it out one of the biggest bugbears we had when we first started was we were given this box of tools and we were basically told, “That’s the toolbox”. Not what all the tools were in it. “There you go. Go off and run it” and it was left [to us] so there was from our point of view, not a lot of training” [23, Recipient]. Due to a lack of training (and a lack of understanding associated with technology), recipients could not use the technologies effectively.

As I mentioned earlier, although the development and provision of training guides assisted recipients in terms of learning about technologies, they were used with caution to minimise the leakage of knowledge outside the firm. This was partially due to IP concerns. In other words, when knowledge is codified in documents, the possibility of its leakage can be higher (as compared to knowledge that is stored in people’s heads). Re-iterating this point, a member of the disseminating team remarked that:

“…there is a document from us that explains exactly how to do it. It even explains why. Process Control have codified it. There are numerous Process Control documents that explain exactly
what it is and how to do it and I now see those as a liability. Great for knowledge retention. Terrible for IP” [5, Sender].

Post implementation support was referred to as the allocation of resources e.g., time, money, and manpower to solve any issues that arose after the use of technology. Disseminating teams were considered as the key help chain in instances where recipients could not solve any technology-related problems on their own. Most technologies had at least one person from the disseminating team who had a dedicated role for providing post implementation support. For instance, one member of the disseminating team remarked that “I still provide technical support for this particular technology so basically if the refineries have questions or any issues relating to this particular technology they contact myself or Josh” [4, Sender]. Similarly, another informant i.e., recipient, with regard to the importance of post implementation support stated that “I think that because of the weekly conference calls that we have been setting up and ongoing work it means that the R&D team [sender team] haven’t just dropped the technology on us [recipients] and walked away. They’ve still remained linked to the project and committed to helping the ongoing optimisation process that we’ve been having so that’s really good” [9, Recipient]. Hence, post implementation support points to agency (i.e., actions taken by the disseminating team to solve issues post implementation to support knowledge integration). Post implementation support is critical because if ongoing support is not maintained, the effectiveness of technology can be at stake.

Overall, the seven technologies confronted varying levels of technical issues (e.g., breakdowns, malfunction, and maintenance issues) post implementation. However, major issues that arose post implementation were associated with Technology E, and in this instance, recipients did not have the knowledge and skills to solve issues. Additionally, there was limited support from the disseminating team as the key knowledge source within the disseminating team had left the organisation. For instance, a member of the recipient team remarked that:
“...we do pull our help chain [from within sender team, however.] the developer of that technology has now moved on, the people coming in and looking after that project portfolio are not as well over the details of that chemistry” [16, Recipient].

The above quote points to the gap in knowledge (i.e., lack of expertise, and codified knowledge), and this indicates that when issues cannot be resolved due to a lack of knowledge and expertise, knowledge cannot be effectively embedded into recipients’ daily routines. In summary, when recipients received proper training in terms of using technology, and post implementation support (i.e., solving technical and maintenance issues), technologies were effectively embedded. Thus, proper training of recipients, and post implementation support represented effective knowledge integration trajectory. On the other hand, a lack of proper recipient training and a lack of post implementation support represented a less effective knowledge integration trajectory as depicted in Figure 11.

**Knowledge co-integration.** As explained earlier, effectiveness of knowledge integration depends on how the earlier processes i.e., knowledge co-creation, and co-implementation unfolded. Generally speaking, when knowledge was co-created, and the implementation processes were undertaken collaboratively, knowledge was more effectively integrated. That is, knowledge was more effectively embedded into recipients’ daily routines. For instance, one member of the disseminating team remarked that “the ones that we’ve co-created with [recipients] are the ones that have implemented it faster and who still use it now” [4, Sender]. Most respondents contended that knowledge was effectively embedded into their daily routines because the technologies that were implemented effectively addressed recipients’ needs. In other words, “They [recipients] won’t use it [technology] if they don’t need it” [4, Sender]. Supporting this argument, one respondent remarked that:

“...knowing your customer and their needs [is important]. That’s obviously the really important bit and it’s about that co-development concept that’s really important. It touches on a few things. It makes sure that the technology is relevant to the customer and also gets buy-in from the customer that it’s relevant to them and they get input into the development but it really is a customised solution for them” [29, Sender].
By involving recipients (particularly the shopfloor workers or operators), the relevance of technology for daily use was further enhanced. For instance, one of the technology operators stated that “I think we’re fairly good at embracing technology. If something is introduced that’s more efficient and makes my job as an operator easier we’re pretty good at embracing it” [24, Recipient].

Knowledge co-integration process involved embedding knowledge into organisational system, embedding knowledge through codification, and undertaking knowledge handover. I found that knowledge can be effectively embedded into organisational systems by means of embedding knowledge into daily routines through standard procedures (i.e., following daily checklists, and maintenance checklists), and automation. For instance, with regard to following checklists, one informant stated that “I think it needs to be a daily visual element to it where they look at it and go, I need to do this. I need to check this. I need to place attention for a part of my day on this piece of equipment to make sure it’s operating the way it should be operating” [17, Sender]. The underlying rationale for embedding knowledge into recipients’ daily routines was the repetitive use of technology. For instance, one informant stated that “It’s got to be routinely in use otherwise it gets forgotten, it falls into disuse and it gets forgotten” [31, Sender]. Additionally, undertaking routine maintenance of technology was also considered as key to knowledge integration. Supporting this argument, one informant stated that “that equipment is going to scale up over time and it’s going to deteriorate and get worse, so you have to have somebody to look after it” [7, Recipient]. This quote illustrates that much like a car that needs to be regularly serviced for a better performance, physical technologies also need to be maintained to enhance their performance over the long-term.

To further enhance the way in which knowledge is embedded into daily routines, another important process was automation. The key rationale for automation was standardising the way technology was routinely used, and reducing human agency. That is, when technology
is automated, the mundane (but important daily tasks) are allocated to technologies to perform, rather than human beings. In this way, there is a very standard process of undertaking a task, and this can minimise any likelihood of knowledge loss particularly when recipients rotate or leave the organisation. Supporting this argument, when asked about the importance of technology automation, one member of the disseminating team stated that:

“...the technology needs to be locked in and embedded where the operation of that technology is not dependent on know-how or experience. There is a very specific way to operate that technology. That’s the only way to do it and now we’re seeing this as a key feature of any best practice transfers. They need to be embedded into our systems so that it’s not up to that person that happens to operate it really well, when he moves on or leaves the company that people don’t know how to do it” [25, Sender].

Apart from the standardisation of routines, automation was also considered to minimise knowledge loss. One of the informants argued that automation of routines can lead to effective knowledge integration as human beings may forget, but if you “tell the computer to do something, it will do that thing every time, every single time until someone tells it not to but it won’t forget. People can forget, or people can decide not to do but computers don’t have that option” [31, Sender].

Embeddedness through codification involved documenting knowledge in best practice documents, and organisational systems. For example, codification practice included cataloguing emails, reports, manuals, training documentation, and knowledge in any other forms that was deemed to be important through the organisation’s record management system. The level of codification across the seven technologies varied. Generally speaking, the technologies that had comprehensive documentation associated with the use, and maintenance were deemed to be well codified. For instance, one informant remarked that “In terms of sustaining the process we’ve got all the documentation in place; the training documentation and we’re developing the maintenance strategies so that should sustain the process” [10, Recipient]. The key underlying reason for codifying knowledge was observed in terms of sustaining knowledge, preventing knowledge loss, and re-invention of the wheel. In some
instances whereby the knowledge codification process was not undertaken effectively, some concerns regarding knowledge loss, and reinvention of the wheel was experienced. For instance, one of the respondents stated:

“...I’ve often talked to Technical Manager level people about we need this thing [documentation] because what you find reasonably often is a new Engineer turns up in a refinery or in the area and thinks they see an opportunity but we’ve flogged that horse to death. There is a good reason why we operate this way and not that way and they’ll spend six months learning that, relearning it and then go back to how we used to run it and potentially that costs a lot of money so in terms of an improvement model with the wheel and the wedge, we don’t have a wedge so a written wedge to say “This is the history of why we operate like this” and I think that you could be even more rigorous and expand to be peer reviewed and R&D team [sender team] would have some input and this becomes everything technically we know about how to operate a refinery” [20, Recipient].

Another important process that was central to knowledge integration was undertaking in-depth knowledge handover. This process involved passing on knowledge to individuals replacing the incumbent. Turnover or people movement e.g., rotation, voluntary and involuntary turnover, was observed by respondents as the reality of the organisational life. People movement was considered a key challenge for both parties (i.e., disseminating and recipient teams). However, movement of people was more frequent among recipient teams. Movement of recipients created opportunities and challenges. Generally speaking, recipients experienced job rotation every two years, and this contributed to career progression. On the other hand, it created challenges in terms of sustaining knowledge that was learnt over this period. However, loss of people from the disseminating team was considered even a more challenging phenomenon partly because individuals had spent longer in their roles. For instance, one member of the disseminating team stated that “If I win Lotto [lottery], then see you later, [this organisation] then doesn’t have that knowledge that it’s been collected over the last 15 years” [2, Sender].

Members of disseminating teams generally worked for longer in their roles, and throughout this period, they gained more knowledge, and experience. For this reason, turnover at their level was perceived to result in a significant knowledge loss. Overall, turnover was
considered a key disruption to how knowledge is embedded and sustained in the organisation. When knowledge is co-created, and co-implemented, the first group of people who are involved in the process generally have a good grasp to embrace the technology. However, as roles change, and other people take over, knowledge gradually declines. Supporting this remark, one informant posited “When people change roles by that stage generally the excitement is not there anymore; it’s just day-to-day business and the handover doesn’t get the same energy and so knowledge declines” [30, Sender]. The quote points to a lack of active agency which can lead to ineffective knowledge integration.

In instances whereby turnover was more frequent, and knowledge handover was also undertaken poorly, knowledge was ineffectively integrated, and this resulted in relearning. For instance, the processes that led to less effective integration involved a lack of a formalised handover, and the extent to which the predecessors spent inconsiderable amount of time to coach the incumbents. For instance, one respondent remarked that:

“There’s a lot of stuff that we learn over time e.g. Alexander was telling a story about the last time we cleaned [the technology] and he thinks basically that was about the year 2000 because he can sort of remember about this time. He thinks he remembers who was in charge in the Ops area, so his timeline was roughly about 2000. Okay, when Alexander walks out in 20 days no-one is going to know that. Everyone who was around when that happened last has retired. We’re going to go and relearn that lesson...Now, we’ll work it out because someone is going to go and do a pressure survey and spend a lot of time scratching their head going, “We can’t get enough flow down this line” and we’ll clean it but we could know it already” [20, Recipient].

The above quote is a good example of how knowledge can be relearnt or lost when it is not effectively passed on to the incumbent. Furthermore, codified knowledge also required handover, and its importance was mainly observed in terms of understanding the rationale and history of codified knowledge, and how it can be used more effectively. For instance, one of the respondents who was in his final few days of retirement remarked that:

“For argument’s sake, I will be sitting down and sorting through my stuff and I will be just on my own, what’s important and what’s not and it will end up in a box or a file or something and that process might take me the last two weeks that I’m here but yes, for two weeks you might easily do that with someone else in the room where their job is yeah, “This is deleted because
of this, this is deleted because of that. This I feel is worth saving because of this” and you get a five-minute story about that. ... It might sound quite boring in terms of listening to a couple of weeks of stories and yes I will file this under this for that reason but someone can bring that to light to say, “Ah yes, that happened in such and such a year and it will be on record here. Otherwise it’s a dead record that people search and it’s hard to search a dead record and come up with gems” [21, Recipient].

Although role handover to an extent was considered useful for retaining valuable knowledge, however, it was not considered the cure. For instance, one informant who was in the last few days of his retirement commented that “you can teach a person book learning and you can take them through a few examples but you can’t guarantee diagnosis. People make different leaps at different times or at what speed do people connect the dots” [21, Recipient]. This helps to explain that handover to an extent can help with regard to the transfer and retention of knowledge, however, “diagnosis” and “connecting dots” require direct experience, and history respectively. That is why, disseminating and retaining tacit knowledge is a challenging undertaking. Due to turnover, it was observed that a significant aspect of knowledge that gets lost is tacit knowledge which is learnt over time. History and exposure to certain ways of solving problems require the direct experience of the person to understand the intricacies of the problems.

Another aspect of knowledge handover was retraining recipients, particularly in instances whereby knowledge handover by recipients was not undertaken effectively. Disseminating teams were considered as the key repository of knowledge, and they retrained recipients when recipients had lost knowledge because of poor handover. For instance, one member of the disseminating team remarked that “We do occasionally though get a new Engineer in so he gets the message, he does all the implementation but he’s still not fully up to speed – he or she. They get in touch with us and that’s when we do a bit of in-situ training so we’ve had to do quite a lot of that, one-on-one” [5, Sender].

**Knowledge co-evolution.** Knowledge co-evolution included the incremental improvement of knowledge with the collaborative effort of disseminating and recipient teams
post knowledge co-integration phase. Key themes that emerged relating to knowledge co-evolution included collaborative learning from previous implementation, and recipient-centric change. What is central about the knowledge co-evolution dimension is the sender-recipient collaboration.

Disseminating and recipient teams engaged in collaborative learning by understanding what works and what does not work from previous implementation, and refining knowledge based on learning from previous implementation. Some technologies were implemented across multiple locations. Hence, after every subsequent implementation, lessons were captured, and were incorporated for further improvement. For instance, one informant stated that “based on the learnings from that project we immediately dismissed a few technical things [that] didn’t work” [13, Sender]. Further, risks associated with the technology were incrementally reduced as lessons were learnt. Risk reduction was as a result of learning from previous implementations, as one informant remarked that “we took the learnings from [location A] and [location B] and transferred it to all the others” [13, Sender]. However, besides drawing lessons from the first implementation, the technologies that were more effectively implemented previously served as precedents for other recipients, generating buy-in for the technology among recipients. For instance, one informant remarked that “I suppose we rolled out one of the improvements to [location A] first, saw that [it was] working well and rolled the same thing out to [location B] and now I’ve shown those results to [location C] and all of a sudden they say, “Yes, we want that too please” [8, Sender]. In contrast, technologies that had no precedents were relatively more difficult for the disseminating team to implement. For instance, one informant remarked that “We had not done it anywhere so we rock up at [recipient’s location] and say, “We can help you use our technology” and they say, “Okay, where have you done this? Where’s your proof?” [5, Sender].
Recipient centric change involved incorporating recipients’ feedback for knowledge refinement, and simplifying knowledge based on recipients’ feedback. For instance, one respondent stated that “prototype probably didn’t have enough in terms of getting everybody knowing what’s going to come through, so some of the people [recipients] were going, “Oh, this valve here, it’s in the wrong spot,” so you’ve got some gripes and some complaints around there” [3, Sender]. The collaborative effort of both disseminating and recipient teams led to further refinement of knowledge. One member of the disseminating team remarked that “without the customer [recipient] being engaged in that and being part of that implementation we wouldn’t have got the feedback so quickly for us to change it or improve it” [4, Sender]. Recipients’ input was considered key to evolution success as it contributed to further enhancement in technology. Recipients were put in the spotlight of evolution as “getting [their] feedback on where it’s not working, or the additional functionality” [4, Sender] was considered key to knowledge evolution. Further, the benefit of co-evolution of knowledge is that it gives a sense of shared ownership to all parties involved. For instance, one informant stated that “the process of evolving that thing [technology] gives the people who are involved in that evolution ownership” [31, Sender]. So far, data showed that agency involves the collaborative effort of both parties, and this is central to executing all processes effectively, including knowledge co-evolution.

Co-evolution of knowledge also meant that by capturing recipients’ input, technology was developed in such a way that was user friendly, and had better utility. Further, improvement of a technology that had better functionality and made recipients’ job easier was also considered key to effective use of knowledge. For instance, one informant stated that “I think probably the best thing you can do if you want a technology embedded is it’s got to make people’s lives better” [5, Sender]. This meant that “they [recipients] must see that it takes less effort on their part to achieve a better result” [5, Sender].
However, increased automation led to recipients’ fear of job losses. Hence, increased automation was a barrier to knowledge co-creation. Additionally, increased automation was reflective of less effective knowledge integration trajectory as recipients (i.e., shop floor workers) were afraid of losing their jobs; hence they did not contribute toward evolving knowledge. For instance, one informant argued that “we have probably halved the number of people operating the [G technology]” [20, Recipient]. Technology operators generally had a fear of job losses due to automation. As mentioned earlier, making technology user friendly and with higher functionality was regarded to improve recipients’ life, however, from recipients’ perspective, “making the job easier means that we can do with less people” [23, Recipient]. In contrast, automation of technology from the disseminating team’s perspective was considered as a long-term sustaining solution. However, operators or users see things from a safety perspective whereby their role is to provide additional safeguards for detecting unexpected errors. For instance, one informant stated that “[this organisation] has been able to really reduce the amount of people that are operating each of the plants because of automation, because of good online sensors. We know our process well. The main reason you need to have surplus people is to manage unexpected things, manage things going wrong” [25, Sender].

However, increased automation emerged as a barrier to co-evolution because recipients (i.e., technology operators) had a fear that their input for improvement might lead to a further improvement in technology which could make their job redundant. For instance, one member of recipient team (i.e., technology operator) claimed that “I don’t want to give any suggestions for technological advances. It could do me out of a job because there’s thousands of them. We work in a 1970s environment. Everything we operate and everything we touch is old” [24, Recipient]. Therefore, when the needs of recipients (i.e., particularly technology operators) are not considered, such as retraining them for other jobs, their knowledge cannot be captured, and
this can limit the possibility of co-evolution which could lead to further enhancement in knowledge. Therefore, knowledge evolution without recipients’ involvement (i.e., technology operators) can be reflective of less effective knowledge integration trajectory.

Two informants (technology users) were particularly concerned and argued that knowledge evolution (in this instance, automation) and employment do not necessarily co-exist and do not work harmoniously. Hence, the misalignment between evolving knowledge and losing employment was reflective of an ineffective knowledge integration trajectory. For instance, one informant stated that “a lot of us are considered unskilled labourers and generally it’s the people digging ditches who are scared of a backache or a digger” [23, Recipient]. Among this group of people, new technology implementation was considered as a significant threat to their employment. When asked what the wider group of operators (technology users) thought in the organisation, one informant argued that “it’s a fairly common thing that when technology is installed the first thought is okay, that will mean less jobs. That means that someone will be losing a job somewhere” [23, Recipient].

Other factors that contributed to a lack of evolution included relearning and change resistance. As mentioned earlier, relearning occurs when lessons are not learnt (or are not codified effectively). Relearning was linked mainly due to a lack of knowledge codification (or knowledge handover which I mentioned earlier). For instance, on member of the disseminating team remarked that:

“I don’t think we spend enough time writing that knowledge down. We can put a technology into a refinery so take [Technology A as an example]. We can put that into a refinery. How well is that documented? If the people who developed it were no longer here, the people who implemented it were no longer here how would their successors know what on earth it is and how it works? I would bet you that we have not documented that right. We might document how to operate the plant but that’s only part of the story. What is happening and why are we operating it this way? What have we learnt? What have we gone through? What are the experiences?” [31, Sender].

The above quote is a good example which illustrates that when lessons learnt are not codified, the possibility of re-learning can be high particularly when the individuals or team
members who were involved in knowledge co-creation and implementation phases leave the organisation. Thus, relearning represents less effective knowledge integration trajectory.

Change resistance on the other was understood in terms of being happy with status quo and averting risk. Supporting the first concept, one informant remarked that:

“We are happy with the status quo too often so as the Area Engineer in my part of the refinery, there are three different components to my job. Are we on track for today in terms of the production plan, are we doing what we thought we were going to do? If not, I’m out troubleshooting, helping for today but the third and the most important bit is how am I going to drop the cost of production for tomorrow and too many Engineers either don’t spend enough time on that or aren’t empowered enough to do that so they end up just copying and being happy with the status quo” [20, Recipient].

Additionally, some informants viewed organisational tenure (i.e., recipients who had stayed longer in the organisation) as a contributing factor to change resistance. Supporting this, two informants stated that “The guys that have been here 30 years doing this job don’t like change” [26, Recipient], and they are “a little bit stuck in their ways” [2, Sender]. Such a mindset represents a culture of risk aversion which does not celebrate change. Supporting this concept, one informant stated that:

“Sometimes history can also be prejudiced, you know, this is how I’ve seen it, this is how it always is, and to challenge that perception is challenging their capabilities sometimes, so teaching an old dog new tricks can take a while, so we certainly face that in some of the older refineries where there’s a lot of 20-plus year veterans there, they’ve always done it that way, it’s always been that way and then someone’s coming and telling them to do it a very, very different way. “Oh, that won’t work,” and they’re strong individuals because they’ve got a world of experience and they’re very important to the refinery, so you can’t fully bypass, just tell them to get on with it because that doesn’t work. So you have to engage, you have to convince, you have to go through a few iterations of discussion or training or debates” [2, Sender].

The quote above can also be linked to the importance of knowledge co-creation, and its role in facilitating knowledge dissemination, integration, and evolution. Hence, a lack of collaboration between disseminating and recipient teams is unlikely to lead to knowledge evolution. Again, the role of collaborative agency in evolving knowledge is critical. Of the seven technologies, most of them evolved. That is, disseminating and recipient teams collaboratively worked together by incorporating their knowledge and learning to further
enhance the aforementioned technologies. Most importantly, this collaborative agency was reflective of effective knowledge integration trajectory which persisted throughout all aforementioned processes i.e., knowledge co-creation, co-implementation, and co-integration.

However, some technologies (particularly Technology F) did not evolve, and the underlying reason for this inertia was a lack of recipients’ needs, and a lack of priority for both parties (disseminating and recipient teams). Hence, a lack of collaborative agency in prior phases i.e., knowledge co-creation, implementation, and integration meant that knowledge was not effectively integrated, and nor did it evolve. Thus, a lack of collaborative agency represents a less effective knowledge integration trajectory. That is, when the collaborative efforts of disseminating and recipient teams are low during knowledge co-creation, and co-implementation phases, knowledge is poorly integrated into routines, and this can minimise the possibility of knowledge evolution.

5.7 Discussion

In the Introduction section, I highlighted the importance of knowledge co-creation to knowledge integration based on findings of previous research. Findings of this study further substantiates that key to effective knowledge integration is not only knowledge co-creation, but also collaborative processes in the implementation, integration and evolution phases as well. Earlier, as I explained, six of the seven technologies that were effectively embedded, was due to a collaborative effort of disseminating and recipient teams in the early phases of technology development. Therefore, knowledge co-creation needs to be promoted more widely so that organisations and teams are better suited to embed knowledge into routines more effectively. This collaborative mechanism needs to be maintained throughout all phases of technology transfer so as to achieve a better outcome.
5.7.1 Implications for theory

This study contributes to the knowledge integration and organisational routines literatures in three important ways. First, the study contributes to the agency (Emirbayer & Mische, 1998), and performative perspective of organisational routines literature (Dionysiou & Tsoukas, 2013; Feldman, 2000, 2003) by highlighting the importance of knowledge co-creation which is central to effective knowledge integration. According to Feldman and Pentland (2003, p. 101), “the performative aspect of the routine consists of specific actions, by specific people, in specific places and times.” In the context of this study, the disseminating team members who co-created knowledge with recipients, took specific steps in designing the technology, such as taking into account recipients’ perspectives, and understanding their needs, and incorporating their operational knowledge to increase knowledge utility.

What is interesting in this study is that the collaborative processes (which began in the early stages of knowledge co-creation) persisted as knowledge was implemented, integrated and evolved. Hence, as illustrated in Figure 11, the more effective knowledge integration trajectory consisted of those patterns of actions that were collaborative and coordinated. Whereas, the less effective knowledge integration trajectory connotes a point of separation or divergence. The point is that the performative aspect of routines needs to be collaborative (and not in isolation). Hence I refer to this collaborative effort as “collaborative agency” (Raelin, 2016) which lies at the intersection of sender-recipient transactions. That is, effectiveness of knowledge integration depends on whether knowledge is co-created, co-implemented, and this paves the path to effective integration which ultimately results in evolution. Otherwise, knowledge can stagnate over time, and cease to exist.

Second, the study contributes to the knowledge integration literature by bringing in sociomateriality research which comprises social and material practices (D’Adderio & Pollock, 2014; Orlikowski, 2007; Orlikowski & Scott, 2008; Suchman, 2007). The social aspect refers
to the interaction of actors among themselves (Bucher & Langley, 2016), and with material which includes but are not limited to objects, technologies, artifacts (D’Adderio, 2014), artificial intelligence, and robots (Suchman, 2007). According to Orlikowski (2007, p. 1437), “the social and the material are considered to be inextricably related — there is no social that is not also material, and no material that is not also social.” In the context of this research, much emphasis was placed on codification of knowledge, and routine automation. Automation points to the role of machines as “actors” that have the capability to perform routines while bringing in some form of stability. Hence, this finding suggests that some level of stability in routines is necessary for knowledge retention. Stability in this respect ensures that routines that work i.e., generate value, are maintained and reproduced (Feldman, 2003). The underlying reason for this is that organisational forgetting can occur due to poor codification system (Zollo & Winter, 2002), or turnover (de Holan & Philips, 2004; Thompson, 2007; Ton & Huckman, 2008) if routines are purely left to human actors. Machines as actors can maintain this consistency in performing actions as long as routines are considered by their human counterparts as valuable. A combination of human and machine actors are required for effectively enacting routines where the former is suitable for non-routine tasks, and those that require tacit knowledge, while the latter for purely routine tasks.

Third, the study contributes to knowledge integration literature by incorporating both a process (Langley, 1999; Langley et al., 2013) and trajectory approach (Christianson, 2017; Faraj & Xiao, 2006; Strauss et al., 1985). The process and trajectory approaches were complementary in terms of building the empirical process model. By using the process perspective, I built the process model which encompasses knowledge co-creation, knowledge co-implementation, knowledge co-integration, and knowledge co-evolution. The trajectory approach allowed me to cluster processes into two trajectories: more effective and less effective knowledge integration. This finding is interesting because it brings to the fore processes that
occur before and after knowledge integration. From a process perspective (Langley et al., 2013), the order and time in which the actions unfold are important. More important, the study distinguishes between various types of actions e.g., perspective taking and collective sensemaking, and a lack of these processes, and how these affect knowledge integration.

5.7.2 Implications for practice

Findings of this study have important implications for managers, leaders, organisations, and practice overall. First, knowledge integration should not be considered as a standalone process. Rather, the inter-relatedness of each process i.e., knowledge co-creation, co-implementation, co-integration, and co-evolution should be made more explicit and visible. For instance, managers can develop flow charts or diagrams that demonstrate the sequential order of the processes. Additionally, managers need to ensure that technology transfer projects are undertaken in a more structured way by involving members of disseminating and recipient teams early to co-create knowledge. The collaborative effort of disseminating and recipient teams can minimise not only design errors, but also foster psychological ownership. As a result, the co-created knowledge can be easily embedded into recipients’ daily routines.

Second, turnover can bring in opportunities and pose challenges at the same time. Opportunities can include the transfer of knowledge and capabilities to other parts of the organisation, whereas threats can include loss of tacit knowledge which is often developed by direct experience over time. Managers need to balance people movement by developing strategies to ensure that knowledge is not lost as a result of people movement. Additionally, employees and teams need to be given the time and permission to reflect on their experiences. By doing, they are more likely to share valuable knowledge which may be beneficial for further improvement of knowledge integration. One strategy that managers can consider is a longer and more formalised handover mechanism whereby the predecessor spends a considerable amount of time with the incumbent to transfer knowledge. Whilst a longer handover period can
assist in the transfer of knowledge, however, it can be costly for organisations. Therefore, there needs to be a trade-off between longer handover which can lead to better knowledge transfer and cost saving.

5.8 Limitations and directions for future research

This study has three key limitations that need to be acknowledged. First, data was collected from a single organisation, and industry (i.e., mining). It is likely that certain processes are unique to the organisation. However, the lessons learnt from this study can be applied in other contexts as well. Future research can draw on data from several industries (e.g., manufacturing, retail, and education) to look for patterns of actions that represent the knowledge integration trajectories (i.e., more effective and less effective knowledge integration trajectories) as found in this study.

Second, findings are based on one data source i.e., interviews. However, by studying multiple cases of technology transfer, and by incorporating perspective of disseminating and recipient teams, I was able to gain in-depth understanding of how the various processes that led to effective and less effective knowledge integration played out. Additionally, interviews are a source of rich data (Spradley, 1979), and the findings can be transferable to other settings where knowledge integration has strategic value. By capturing views from both parties i.e., disseminating and recipient teams on different phases i.e., knowledge co-creation, co-implementation, co-integration, and co-evolution, and across different levels—technology operators to senior managers, I was able to identify two trajectories: more effective and less effective knowledge integration trajectories. These two knowledge integration trajectories are based on the idea of processes as narratives (Fachin & Langley, 2017). Processes that are derived from narratives are based on how people make sense of and reconstruct their experiences (Fachin & Langley, 2017). Future research can expand on knowledge integration
trajectory approach by collecting longitudinal data to explore how knowledge integration evolves over time.

Third and finally, informants in this study belonged to two parties i.e., R&D team (disseminating team) and recipients (knowledge users). Although this form of categorisation was based on the organisation’s structure, however, in some organisations, such a classification i.e., disseminating team and recipient team may be non-existent. It will be interesting to explore when respondents self-identify themselves as senders or recipients of knowledge, and whether a lack of formal categorisation of teams’ roles into disseminating and recipient teams can lead to different patterns of knowledge transfer processes, and how these processes can affect knowledge integration.

5.9 Conclusion

The key objective of this study was to explore how knowledge is effectively integrated within an organisation’s daily routines. I found that effectiveness of knowledge integration depends on the collaborative agency of various actors i.e., disseminating and recipient teams, at various phases i.e., knowledge co-creation, co-implementation, co-integration, and co-evolution. These processes are intertwined, and need to be undertaken collaboratively to achieve an enhanced outcome. Where the collaborative agency was either weak or non-existent, knowledge integration was poor, and as a result, the possibility of knowledge evolution was limited.
Chapter 6: General Discussion
6.1 Foreword

In this chapter, I provide an overview of the contributions arising from three empirical studies (Chapters 3, 4, and 5), and how they have enhanced our understanding of team disseminative capacity (DCAP) processes. This chapter is structured as follows. First, I begin with a brief summary of findings from the three studies. Next, I highlight the overall theoretical contributions of the studies with respect to team DCAP, and their implications for practice. Finally, I point out the limitations for the study, and offer potential research directions.

6.2 Summary of findings

In Study 1 (Chapter 3), I empirically showed that team DCAP involves the processes of knowledge co-creation, implementation, and integration. I found that knowledge co-creation is central to the subsequent processes of knowledge implementation and integration. Knowledge co-creation emerged as the function of perspective taking and collective sensemaking. This characterisation is unique because on the one hand perspective taking allows disseminating teams to develop a recipient-centred approach toward understanding recipients’ needs, and how these needs can be addressed through their involvement. On the other hand, collective sensemaking promotes a collaborative effort in terms of developing a collective understanding relating to the knowledge.

In Study 2 (Chapter 4), I tracked the processes of perspective taking and collective sensemaking in real-time. The key underlying rationale for tracking knowledge co-creation involving perspective taking and collective sensemaking processes was its central role to effective knowledge dissemination. The findings revealed that these two processes are intertwined and iterative—such that the process of perspective taking influences collective sensemaking, and this in turn leads to enhanced perspective taking. However, in order for these processes to occur effectively, early involvement of key stakeholders was central. Early involvement of key stakeholders meant that knowledge diversity (i.e., strategic/technical
knowledge, operational knowledge, and specialised design and engineering knowledge from the disseminating team, recipient team, and external contractors) were incorporated. Thus, through the diversity of knowledge, and the iterative processes of perspective taking and collective sensemaking, the outcome that resulted was co-created knowledge that had four characteristics: multifacetedness, utility, shared ownership, and enhanced quality (MUSE). Additionally, key knowledge co-creation facilitators included psychological safety climate, and team structure i.e., formalisation of meetings, and role clarity. Key inhibiting factors were risks and uncertainties around the project.

In Study 3 (Chapter 5), I explored the implementation and integration processes further to disentangle processes undertaken by disseminating and recipient teams that are central to effective knowledge implementation and integration. Building on findings of Study 1 (Chapter 3), which conceptualised team DCAP as the processes of knowledge co-creation, implementation, and integration, I found that knowledge co-creation had a spill-over effect, and influenced the effectiveness of subsequent processes i.e., co-implementation, and co-integration. An important process that emerged following the knowledge co-integration process is knowledge co-evolution. The prefix “co” accentuates the collaborative effort of disseminating and recipient teams in terms of undertaking the processes mentioned earlier. I found that neither party working in isolation can achieve an optimal outcome in terms of effectively embedding knowledge into their routines. Based on whether the processes mentioned earlier were undertaken in collaboration or isolation, I developed two trajectories: more effective and less effective knowledge integration trajectories. The former points to those sequence of processes that are performed with the collaborative effort of disseminating and recipient teams, and the latter demonstrates those processes that either lack collaborative effort, or a low level of collaborative effort.
6.3 Overall theoretical implications

This thesis moves the body of discipline knowledge forward by developing process models that are based on grounded theory approach (Straus & Corbin, 1998). Specifically, I adopted an interpretive approach because it draws on “a perspective that gives voice to the interpretations of those living an experience” (Corley & Gioia, 2004, p. 178). First, this thesis brings in a blend of process perspective (Langley, 1999; Langley et al., 2013; Mohr, 1982; Van de Ven & Poole, 2005; Whitehead, 1929) and trajectory approach (Christianson, 2017; Faraj & Xiao, 2006; Strauss et al., 1985) into DCAP and knowledge transfer literatures. By doing so, I extend existing research on DCAP which is largely variance-based. The process perspective on team DCAP unravels the processes of knowledge co-creation, co-implementation, co-integration, and co-evolution. As such, the sequential ordering of processes is central to team DCAP. Knowledge co-creation—being the first team DCAP process emphasises collaboration (Bruns, 2013) among disseminating and recipient teams. Through this collaborative effort which is a function of the two intertwined and iterative processes of perspective taking and collective sensemaking, the diversely held knowledge i.e., strategic/technical knowledge, and operational knowledge of the disseminating team, and recipient team respectively can blend together, and bring to fruition a new body of co-created knowledge that comprises elements of multifacetedness, utility, shared ownership, and enhanced quality (MUSE).

Additionally, by bringing in the trajectory approach, I juxtapose two trajectories: more effective and less effective knowledge integration. The trajectory approach highlights the importance of knowledge co-creation, and co-implementation to subsequent processes of co-integration and co-evolution. Essentially, knowledge co-creation is a collaborative effort of disseminating and recipient teams whereby recipients’ problems (i.e., needs), and solution to the problems (i.e., knowledge held among disseminating and recipient teams) coalesce. Hence,
through the process of perspective taking, disseminating teams make a conscious effort by asking recipients about their needs, and involving them to contribute their operational knowledge. This form of perspective taking is a conscious effort which allows disseminating teams to gain an accurate understanding of recipients’ needs as opposed to their potential needs. Therefore, when disseminating teams make a deliberate effort to take recipients’ perspective by involving them in the knowledge creation process, the likelihood of assumptions can be minimised, and this can lead to reduced errors in design. Additionally, the process of collective sensemaking allows disseminating teams and recipient teams to be congruent in terms of performing their tasks, coordinating their actions (Mohammed et al., 2010), and aligning their objectives. As a result, the knowledge that is co-created in this fashion can be effectively implemented.

Second, the study contributes to team DCAP literature by bringing in collaborative agency (Emirbayer & Mische, 1998; Raelin, 2016). Collaborative agency points to the importance of a collective effort of disseminating and recipient teams in terms of executing the aforementioned processes i.e., knowledge co-creation, co-implementation, co-integration, and co-evolution. For instance, the process of knowledge co-creation which emerged as functions of the processes of perspective taking and collective sensemaking, cannot be undertaken in isolation. As I showed in Chapters 3, 4, and 5, the disseminating team has technical knowledge, while the recipient team has operational knowledge. The two parties need to co-create knowledge, so that it can be effectively implemented. The collaborative agency of disseminating and recipient teams is not only vital during knowledge co-creation phase, but also during subsequent processes i.e., co-implementation, co-integration, and co-evolution.

Third and finally, the study brings social constructionist theory (Berger & Luckmann, 1966; Brown & Duguid, 2001; Corley & Gioia, 2005; Tsoukas, 1996) into DCAP and knowledge transfer literatures. Berger and Luckmann (1966, p. 15) argued that “all human
‘knowledge’ is developed, transmitted and maintained in social situations”, which requires frequent exchange of meanings and interpretations. There is a dearth of research that views DCAP as a collective effort of senders and recipients in terms of disseminating knowledge. By conceptualising team DCAP as the processes of knowledge co-creation, co-implementation, co-integration, and co-evolution, I have bridged this gap by placing sender-recipient interaction and collaborative effort as the foundation stone for effective knowledge dissemination.

Thus, from a social constructionist perspective, knowledge is socially constructed (Aram, 2004; Sayer, 1997; Tsai, 2001; Tsoukas, 1996) through ongoing interaction among individuals (Empson, 2001). In this way, individuals and groups can bring meaning to their world which allows them to act accordingly (Rasche & Chia, 2009). I demonstrated in earlier chapters (Chapters 3, 4, and 5) how knowledge is socially constructed by disseminating and recipient teams through intertwined and iterative processes of perspective taking and collective sensemaking. The point is that once knowledge is co-created, it can be effectively disseminated, integrated, and evolved.

6.4 Practical implications

This research has several important implications for practice. First, a plethora of research (Minbaeva, 2007; Minbaeva & Michailova, 2004; Minbaeva et al., 2018; Schulze et al., 2014; Tang, 2011; Tang et al., 2010) has focused primarily on the role of senders when it comes to disseminating knowledge. Whereas findings of this research revealed the vital role of recipients in terms of enhancing knowledge dissemination. Specifically, recipients can contribute by offering their operational knowledge and this arises from their experience of performing their day-to-day job. For example, in this way, technology that is developed can be ergonomically suitable which can lead to enhanced productivity and reduction in job-related injuries (May & Schwoerer, 1994). Further, recipients as users of technology can be a key source of innovation (Bogers, Afuah, & Bastian, 2010). Therefore, managers and policy makers
need to consider recipients as pivotal contributors in the knowledge co-creation process. That is, managers need to ensure that key members of disseminating and recipient teams are involved in knowledge creation projects.

Second, knowledge sharing and co-creation do not happen simply by having members of disseminating and recipient teams in a room. Managers need to ensure that they are aware of factors that enhance (or constrain) interaction between the two parties. For instance, in Study 2 (Chapter 4), I found that role clarity, meeting formalisation, and psychological safety facilitate knowledge co-creation process. Managers need to ensure that roles and responsibilities of project team members are clearly defined so that team members can coordinate their actions to enhance team performance (DeChurch & Mesmer-Magnus, 2010; Marks, Sabella, Burke, & Zaccaro, 2002). Another enabler of knowledge co-creation is the way meetings are run (Allen, Beck, Scott, & Rogelberg, 2014; Bales, 1950). To increase effectiveness of meetings, managers need to ensure that project team leaders are trained to run meetings in a formalised structure. As discussed in Study 2 (Chapter 4), when meetings are run in a formalised structure, the member of the project team who leads the meetings produces meeting minutes (e.g., agenda, when and by whom a task needs to be completed). This practice not only enhances clarity of information and actions that need to be taken, but also increases team members’ accountability.

Additionally, managers need to create a psychologically safe climate i.e., an environment in which project members are able to express ideas without any repercussions (Edmondson, 1999). Psychological safety enhances the quality of interaction among team members wherein members can express disagreements or accept criticism associated with tasks without taking them personally (Bradley, Postlethwaite, Klotz, Hamdani, & Brown, 2012). One way managers can create such a climate is to be conscious of the team composition e.g., position or status of team members (Mathieu et al., 2008), and their learning styles. For
instance, I found that when managers and their subordinates are present in the same room, it is possible that the subordinates have an unwillingness to share opinions openly due to a perceived fear of being wrong. This in turn can minimise the likelihood of having an open dialogue among team members. Within meetings, it is possible that project team members have arguments or disagreements relating to agendas or tasks. However, such disagreements may not be expressed openly when subordinates’ managers are present in the room. In summary, managers need to ensure that team members present in meetings feel comfortable to express their opinions without any perceived fear of being judged or punished in anyway. Building such an environment is a key task in its own right which can then pave the path for effective knowledge co-creation.

6.5 Limitations and directions for future research

This thesis has a number of limitations that need to be considered in light of its strengths. Although I highlighted limitations of each study in the respective chapters (i.e., Chapters 3, 4, and 5), the limitations I point out here are the overarching ones. First, the disseminating team-recipient team dichotomy that I have adopted throughout this thesis highlights the organisational context in which these two parties coexist. The roles of these parties were distinctively identified whereby the former had a pivotal role in terms of technology development and its transfer across organisational units, and the latter whose primary role was the application of technologies. When asked about their team membership, respondents self-identified themselves as members of R&D team (disseminating team) or recipient team. In some organisations, this distinction may not be obvious, and various teams within an organisation may engage in reciprocal practices of knowledge transfer and application. In other words, teams can be recipients and senders of knowledge simultaneously. Future research may explore whether the identity of being a member of the “disseminating
“team” or “recipient team” may create any boundaries between these two parties that could inhibit knowledge dissemination.

Second, research was conducted within a single organisation. Certain features were more likely to be unique to the organisation. Although sample size in each empirical study (i.e., Chapters 3, 4, and 5) was small, this limitation does not impact the transferability of the findings. According to Gioia (2018, p. 461), one can generalise from a single case study “if that case generates concepts or principles that are relevant to some other domain.” The organisation in which I investigated the phenomenon of interest i.e., team disseminative capacity, served as a rich source of data to help reveal the processes that are overlooked in extant research. Therefore, findings can be transferred and applied in other settings. For instance, knowledge co-creation can be explored in various settings such as pharmaceutical industry, retail, and education. Within an educational context, for example students are generally treated as passive receivers of knowledge. It will be interesting to explore how student involvement can help improve the quality of teaching, learning, and curriculum that can prepare them for future challenges.

Third, as I mentioned in Chapters 3 and 5, interviews in these two empirical pieces were retrospective. That is, I developed process models by analysing the narratives retrospectively. This is a key strength of this thesis as I captured accounts of various stakeholders i.e., disseminating and recipient teams, in terms of understanding processes that were central to effectiveness of knowledge dissemination. However, some anthropologists have been critical of whether what goes on in reality can be captured through retrospective accounts of actors (Johnson et al., 2003). To minimise retrospection bias, I interviewed multiple respondents across various cases. Additionally, I took accounts of both parties i.e., disseminating and recipient teams, and this process allowed me to gain a more fine-grained understanding of the phenomenon. For instance, in Chapter 3 (Study 1), I pointed to a central process i.e., knowledge
co-creation, that positively influences knowledge dissemination. I gained this fundamental understanding through retrospective accounts of disseminating and recipient teams. I then undertook a longitudinal process research (Chapter 4) by triangulating my findings i.e., over 10 months of non-participant project meeting observation, multiple rounds of interviews, archival data, and survey to track how knowledge co-creation unfolds in real-time. The point is that by providing convincing evidence i.e., accounts of several respondents including members of disseminating and recipient teams (Johnson et al., 2003), I established that knowledge co-creation is central to knowledge transfer effectiveness. In a later study (Chapter 5), I further demonstrated the importance of knowledge co-creation, and the collaborative agency of disseminating and recipient teams throughout team DCAP processes i.e., co-implementation, co-integration, and co-evolution.

Fourth and finally, there is an implicit assumption in the extant literature that senders have a higher power than recipients due to their knowledge capital. Power in this sense is defined as dependency of one party over the other (Emerson, 1962; Twomey, 1978). For instance, dependency can be demonstrated when recipients rely on disseminating team’s strategic/technical knowledge to solve their problems. In the context of my research, the issue of power was not explicitly mentioned between the two parties. However, when considering senders as the principal source of knowledge, it does implicitly infer their knowledge and position power. Therefore, when there is power imbalance (asymmetry), it can blur the myriad ways that both parties can engage in collaborative behaviours. Future research can explore whether power imbalance (or a perception of power imbalance) can impede collaborative behaviour between the two parties which in turn can result in reduced perspective taking and collective sensemaking. Based on findings of my study, the collaborative agency of disseminating and recipient teams infers that this collaborative effort persists on the premise that the two parties are in a power equilibrium (balance).
For example, disseminating team’s dependency on recipients can be illuminated by capturing their operational knowledge as found in this research. Such a transaction between the two parties demonstrates a mutual dependency (Emerson, 1962). In other words, the disseminating team needs recipients so that they can value their knowledge by adopting their technology (in exchange for resources i.e., money). On the other hand, recipients require that their perspective is taken (i.e., needs are understood), and are involved in the creation of knowledge before knowledge can effectively be implemented. Such a collaborative effort of disseminating and recipient teams during the various phases of team DCAP i.e., knowledge co-creation, co-implementation, co-integration, and co-evolution, can prevail on the premise that both parties maintain mutual dependency. As a result, both parties can put mutual interest first, and this is key to effective knowledge dissemination. A perceived sense of disparity in power can result in a lack of recipient involvement, perspective taking and collective sensemaking.

6.6 Conclusion

This thesis provided a process view of team disseminative capacity (DCAP) which constitutes the processes of knowledge co-creation, co-implementation, co-integration, and co-evolution. Central to the effectiveness of these processes is the “collaborative agency” of disseminating and recipient teams. That is, unlike passive users of knowledge, recipients are considered as key actors in terms of undertaking the processes. The most fundamental process is knowledge co-creation which involves the intertwined and iterative processes of perspective taking and collective sensemaking. It is through these processes that disseminating and recipient teams collectively co-create knowledge that can be effectively applied by recipients. The collaborative agency of disseminating teams and recipient teams was considered central throughout all team DCAP phases including co-implementation, co-integration, and co-evolution.
It is anticipated that future research can build on the findings of this research to further accentuate the roles of both senders and recipients in terms of influencing knowledge transfer effectiveness. Unlike the old argument that considers recipients as passive recipients of knowledge, this research showed that their operational (practical) knowledge is vital for complementing disseminating team’s knowledge. It is through shared endeavour that knowledge can be effectively co-created which can subsequently be implemented, integrated, and evolved.
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# Appendices

## Appendix A: List of interview informants

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<thead>
<tr>
<th>Inf #.</th>
<th>Position</th>
<th>Overall experience</th>
<th>Number of years in current role</th>
<th>Membership</th>
<th>Technology*</th>
</tr>
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<tbody>
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<td></td>
<td></td>
<td></td>
<td>Sender/Recipient</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Vice President Technology Manufacturing</td>
<td>29 years</td>
<td>3 years</td>
<td></td>
<td>All**</td>
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<td>10 years</td>
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<td>10 years</td>
<td></td>
<td>All**</td>
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<tr>
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<td>3 years</td>
<td></td>
<td>All**</td>
</tr>
<tr>
<td>5</td>
<td>Senior Research Consultant</td>
<td>25 years</td>
<td>2 years</td>
<td></td>
<td>All**</td>
</tr>
<tr>
<td>6</td>
<td>Process Design &amp; Equipment Development Director</td>
<td>26 years</td>
<td>10 years</td>
<td></td>
<td>All**</td>
</tr>
<tr>
<td>7</td>
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<td>4 years</td>
<td></td>
<td>All**</td>
</tr>
<tr>
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<td>2 years</td>
<td></td>
<td>All**</td>
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<td>4 years</td>
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<td>1 month</td>
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<td>4 years</td>
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<td>5 years</td>
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<td>10 months</td>
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<td>B</td>
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<td>7 years</td>
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<td>Sender</td>
<td>D</td>
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<td>26</td>
<td>Equipment Manager Supervisor</td>
<td>7 years</td>
<td>2 years</td>
<td>Recipient</td>
<td>D</td>
</tr>
<tr>
<td>27</td>
<td>Production Supervisor</td>
<td>21 years</td>
<td>3 weeks</td>
<td>Recipient</td>
<td>D</td>
</tr>
<tr>
<td>28</td>
<td>Senior Reliability Engineer</td>
<td>8 years</td>
<td>2 years</td>
<td>Recipient</td>
<td>D</td>
</tr>
<tr>
<td>29</td>
<td>Senior Process Consultant</td>
<td>15 years</td>
<td>11 years</td>
<td>Sender</td>
<td>E</td>
</tr>
<tr>
<td>30</td>
<td>Senior Scientist</td>
<td>10 years</td>
<td>1 year</td>
<td>Sender</td>
<td>E</td>
</tr>
<tr>
<td>31</td>
<td>Program Manager</td>
<td>10 years</td>
<td>3 years</td>
<td>Sender</td>
<td>E</td>
</tr>
<tr>
<td>32</td>
<td>Process Control Engineer</td>
<td>13 years</td>
<td>10 years</td>
<td>Recipient</td>
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<tr>
<td>33</td>
<td>Technical Manager</td>
<td>26 years</td>
<td>4 years</td>
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<td>E</td>
</tr>
<tr>
<td>34</td>
<td>Senior Process Consultant</td>
<td>15 years</td>
<td>11 years</td>
<td>Recipient</td>
<td>E</td>
</tr>
</tbody>
</table>

*Names of technology: A, B, C, D, and E

All**: All technologies

Inf: Informant
Appendix B: Study 1 interview protocol

Demographic Summary Sheet
1. Can you tell me a little bit about yourself – what is your name and job title in your current position at [this organisation]?
2. What are your key roles and responsibilities in your current position at [this organisation]?
3. What is your role in technology transfer process?
4. What Department do you work in?
5. How many months/years have you worked at [this organisation]?
6. How many months/years have you worked at the current position?

Interview Questions (Asked from Sender Team)
A. Team disseminative capacity processes
1. Consider the most recent technology that you were involved in the transfer process. What technology was it and what steps did you take in deploying the technology from R&D Team to your customers (recipient teams)?
   - What methods (s) did you use in deploying the technology and who were involved in the dissemination? What made these methods effective/ineffective? Do you think one method was better than the other or worse than the other and why?
   - What measures did you take in documenting the technology you transferred to the recipient?

B. Enablers and barriers of team disseminative capacity
1. What factors enhanced or constrained technology deployment from your team to recipient teams? [Probe: what made knowledge transfer easy or difficult, e.g. clarity of knowledge, learning capability of recipient, teaching capability of source, organisational culture?]
2. Did you receive any training on how to deliver technology to recipients prior to deploying the technology?

C. Team disseminative capacity outcomes
1. What beneficial outcomes did your team achieve from technology deployment to the recipient team? [Probe: To what extent do you think reward, incentives, gratitude, recognition, and/or promotion (if any) contributed to technology deployment?]
2. What benefits do you think did the recipient team achieve from the technology that your team deployed to the recipient team? [Probe: Did they learn a new technology that can
make their job easier? In what way do you think did the technology make recipient’s work easier or safer?

D. Team effectiveness and organisational context

1. What roles do you think did the company’s culture play in your effort to deploy technology to your recipient? [Probe: Do you have an open and flexible boundary?]
2. Did the organisation require you to submit a formal report on the technology you deployed and the knowledge you learnt?
3. Overall, how did you perform as a team in your effort to deploy technology? [Probe: Did your team members get along well with each other, were you competitive or cooperative?]
4. Overall, how did the recipient team perform in their effort to learn the technology?
5. Have there been any occasions whereby you needed to repeat the training or the deployment of the technology to the recipient? If so, what led to the situation to occur?

E. Other questions

1. What was the key challenge that you confronted in terms of deploying the technology?
2. If there is an area that needs to be addressed in order to improve technology deployment, what would it be?
3. Do you have anything else to say that I have not asked you?

Interview Questions (Asked from Recipient Team)

A. Team disseminative capacity processes

1. Consider the most recent technology deployment event that you were involved in. What was it? Thinking of this technology, what steps did the donors (R&D Team) take in delivering the technology to your team?
   - What methods (s) did the donors use and who were involved in the dissemination?
   - What made these methods effective/ineffective? Do you think one method was better than the other or worse than the other and why?
2. What level of training did you receive in order to run and use the technology?
3. When the technology was delivered to your team, did you have sufficient knowledge of how to use the technology or did you have to keep contacting the donors?

B. Enablers and barriers of team disseminative capacity

1. What were the key factors that enhanced or constrained technology deployment from R&D Team to recipient teams? [Probe: what made knowledge transfer easy or difficult,
e.g. clarity of knowledge, learning capability of recipient (your team), teaching capability of source, organisational culture?]

2. To what extent were you involved in the development of the technology prior to its delivery to your team?

C. Team disseminative capacity outcomes
1. What beneficial outcomes did your team and R&D team achieve from technology deployment?
2. To what extent do you think did the deployment of technology contribute to your team operationally? [Probe: In what way did the technology help you?]

D. Team effectiveness and organisational context
1. What roles do you think did the company’s culture play in your effort to learn and adopt the technology? [Probe: Did you have an open and flexible boundary?]
2. Did the organisation require you to submit a formal report on the technology that was deployed to your team?
3. Overall, how did you perform as a team in your effort to learn and use the technology? [Probe: Did your team members get along well with each other, were you competitive or cooperative? Did you share learning with each other]
4. Overall, how did R&D Team perform in their effort to deploy the technology to your team?

Other questions
1. What was the key challenge that you confronted in terms of learning the technology?
2. If there is an area that needs to be addressed in order to improve technology deployment, what would it be?
3. What method do you think is most effective in learning technology?
4. Do you have anything else to say that I have not asked you?
Appendix C: Additional excerpts

<table>
<thead>
<tr>
<th>Representative Quotes</th>
<th>1st Order Concepts</th>
<th>2nd Order Themes</th>
<th>Aggregate Dimensions</th>
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<tr>
<td>• Involve the site [recipients] in the development step so don’t just develop it in isolation. Call upon the sites to provide that input into the development of it, get the engagement of the key stakeholders at the front of the development of the process and you will be a lot more successful in the deployment of the process or technology. It’s a lot less likely for them [recipients] to take on that package of work without being involved with it or having a fundamental engagement with the development of it. I mean all the Engineers here are all extremely smart people and they want to be involved in new technology and so involvement at the start I think is really important [23, Recipient].</td>
<td>Involving recipients</td>
<td>Perspective taking</td>
<td>Knowledge Co-creation</td>
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<td>• They [sender team] are willing to listen to the site [recipient] perspective on things...because often the technology they [sender team] want to implement might sound really good in theory but we have limitations on the process so they might come down and say, “Oh this worked really well in the lab” but we [recipients] say, “Well hang on a minute when we do this, this happens and that might not be the right way” so they [sender team] need to be able to take the site feedback on the process and incorporate that into what they’re trying to achieve...[22, Recipient].</td>
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<td>• We’re now getting to the point where we, through their [recipients’] engineer, or in conjunction with him, are starting to move towards discussion with the production folks so we can make sure what goes in is acceptable to them, because you can’t just go and install something and say “hey, guys, we put something new in last night; you need to run it now” so we need to be in full consultation with them [16, Sender].</td>
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<td>• I guess if you involve some key stakeholders early on they feel more a part of the project and they’re more likely to be proponents for the project, rather than feeling left out and disengaged and not a part of the project. If you can engage them early then that’s key to driving projects...[19, Recipient].</td>
<td></td>
<td>Making recipients a part of the project</td>
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<td>• Their engineer will own it, their operations folk need to own it, their maintenance folk need to own it; that’s why we need to bring the production guys, the operations and maintenance people along for the ride and we’re just about at the point now where that’s starting [16, Sender].</td>
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<td>• People from the customer side may not appreciate that as much as seeing the efforts that people [disseminating team] went to in order to validate the model that we had or that we didn’t have, and then we had to make up, had to analyse and develop to get to a solution. That was, as I say, really first class. But that took time and people [recipients] needed to appreciate that [15, Sender].</td>
<td></td>
<td>Appreciating each other</td>
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<td>• You would see people coming down from sender team to work beside my Engineers...an example was in [x location] there was a Scientist who came to work at [our location] for a month in a particular area so he got to understand the work environment and the issues that our Chemical Engineers had to deal with on a day to day basis so that when he went back to [sender team] he had a better idea of all of the pressures and the requirements and the demands and expectations [23, Recipient].</td>
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<td>• ...I guess getting agreement from all the relevant people [is important] so it’s not just getting a technological agreement from people to say, “Yes, this is an appropriate solution”. It’s being able to sell that level of confidence to the asset owner who is the Production Manager and also the people that operate the equipment as well because they’re the ones that have to deal with the problems out in the field everyday so we need to be able to sell it to them as well and say, “We understand the problem” and explain it as we understand it to make sure that we’re all on the same page [34, Recipient].</td>
<td></td>
<td>Getting everyone on the same page</td>
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<td>• ...making sure the right people are in the room so...[having] all the relevant site people...and people from the R&amp;D team...when we have discussions and questions are raised we can hopefully get the answer sorted out...or agree to a path on how we’re going to progress forward with the right people in the room because that I guess speeds up [8, Sender].</td>
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<td>• ...it was not an easy process to get people all on board in terms of everyone on the same page and believing the same theory and we got that so I think that we did really well- got everyone with a unified theory...[32, Sender].</td>
<td></td>
<td>Aligning objectives</td>
<td>Collective sensemaking</td>
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<td>• It [technology] has to come from both...if it just comes from [R&amp;D team who] are saying, “Oh, hey guys, do this” but then your Manager is saying, “No, I don’t want you to focus on that, I want you to prioritize</td>
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something else” and ultimately you’re going to do what your priority is so [there is a] very strong alignment between what the tech managers on sites are kind of thinking what the priorities are and what R&D team is interested in and supporting us to do...[26, Recipient].

• ...the refineries basically consist of two different organisations. You have Operations on the one side and you have Maintenance on the other side and they have different reporting structures so the issue of scale removal would mostly be part of the Maintenance function so the Operations people are affected by it but they don’t directly get involved with that. It is by and large a Maintenance activity and the expectation is that the Engineering and Maintenance Managers would be interested in that you know and that’s where I can see a difficulty with [sender team] implementation...aligning themselves with Operating people [33, Sender].

• ...build a prototype so the first installation running in an operating plant so you know how it works and you get extra learning there [8, Sender].

• So when the technology was being developed, and the large part of the technology being developed was actually process modelling, so computer modelling of what we think is going to happen. Now, that computer model gets inputs from plant data and experiments that we do, but the large part, what we call the technologies, is the modelling which validates the idea. So while we were going through an iterative process of developing the model, getting the model to a point where it could accurately predict the outcomes for the technology... [9, Sender].

• We’re training the people [recipients] so people understand the concept of what we [sender team] are trying to do, but we work together. We work with these [recipients], yeah, go with them, stay and work there in the plant with the group, coaching, developing and interacting with every person that is required [1, Sender].

• Their training that they gave us as well so this was a new technology that our Engineers were not familiar with and so in coming down to site to implement the technology there was a training side of that that engaged our Engineers as well so it was really important for the Engineers to know the fundamentals from which the technology was based so that they could then take that and implement it with a lot more success [23, Receiver].

• Normally [training is] face-to-face; in those cases face-to-face. Sometimes you can develop a video, or something, but where it’s possible we prefer to go face-to-face [1, Sender]

• A lot of it is presentation, actual face-to-face meetings or teleconferences combined with material and presentations. We use reports and some of the audience will use the report and find it very valuable but that’s specific people but the presentations and communications and emails tend to be commonly used [4, Sender].

• You need stuff to be documented and clearly written down such that the intent is clear, whether that be at the front end of the problem in terms of problem definition or at the back end of the problem in terms of this is what to do. But then you need to, you know, documentation is rarely self-evident or perfect and it needs to be supplemented through a communication process which is usually verbal to convey the ideas and to convince and explain to then allow the documentation to sort of be the permanence of the solution [6, Sender].

• ...[during implementation], you get all the paperwork...We need to know what our operating instructions are and maintenance strategy around the equipment and all those types of things and traditionally they’ve been left to the Ops Centre to sort of work it out [24, Recipient].

• So generally the installations have involved quite a bit of hands on and direct transfer so once the equipment has been in place then the sender team, either one person or several people would have gone to assist with the implementation and set the machinery up as best it could be and go through what procedures needed to be used [11, Sender].

• Typically what happens when you go in, you do the installation; you’ll get a few months where things work quite well and then you get feedback[14, Sender].

• …we don’t have a prototype so we’re going for the ‘this is what we expect that we will do’ and during that [implementation] period we will actually refine the system that we’ve put in and because of that we’ve given ourselves quite a long [implementation] period, 6-12 months which is a significantly long period of time...[8, Sender].

• Well, see, it’s an engineering change out in the refinery; it’s a physical change out in the refinery, so once the site was on board with doing it we worked with the site engineers and the engineering service providers on getting the right design for what they install and for the final version

Developing artifacts
Training recipients to be able to understand and use technology
Use of various training methods (i.e. conference call, hands on training, photographs, videos and presentation) Training documentation (e.g., user manual)
Installing technology at recipients' location
Refining technology

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That’s going in – probably next year – we’re doing exactly that as well [16, Sender].

- We [sender team] work with them [recipients], yeah, absolutely. And for us as we are implementing that we almost become integrated to the team until we make sure that the technologies are working, is producing what we expect and then you have routine follow-up after that [1, Sender].
- Well they [recipients] need to be involved in all of the different aspects like in identifying what needs to be worked on and then monitoring the output, making sure that it is going to meet the requirements and then very importantly planning for the outcomes to be part of the refinery planning [33, Sender].
- ... you’ve got to actually go to the location...understand the customer’s problem and the granularity around when they have issues, what causes the issues; there’s a lot of deep troubleshooting that goes along with that [32, Sender].
- If they [recipients] encounter problems, well then the support mechanisms will all be done as part of the project implementation [16, Sender].
- ...there would have to be some review and continued communication to make sure that you know how it’s gone and that you’ve picked up any problems and tried to help resolve them…[5, Sender].
- There would have been…visits to maintain the systems or to do some troubleshooting…The other thing was that the customer laboratory in that case didn’t understand or the nature of the technology hadn’t been communicated to them sufficiently well that they understood that they needed to ask for help…[11, Sender]
- …normally [there is] a follow-up as well to see how successful the solution is in practice so if we have issues during implementation they [sender team] are always available to help [34, Recipient].
- We need to make sure we are ready to support them…[and not say] Oh sorry, we’re too busy [7, Sender].
- Certainly the access to anyone we needed So be it [sender team] or anyone else onsite definitely enhanced…[19, Recipient].
- …support doesn’t always come and it’s not always called for early enough either so some people [recipients] won’t call for help soon enough [3, Sender].
- Also it’s a learning journey for us in terms of helping the locations know how to keep the technology and also still have a challenge on the interface with for example the reliability maintenance organisation to get technologies sustained…[4, Sender].
- …today the [x location] laboratory operates autonomously. They’re independent. Very rarely do they get into trouble so that technology is entrenched; it’s embedded there.

We lost the Consultant who worked on it and the Chemical Engineer is about to move out of the area so it will depend on how well that transfer happens to the new Consultant and the new Chemical Engineer at once so I don’t know how well we have lined up that knowledge transfer for the next person. I guess it will depend on how well their handover goes with the previous Engineer [22, Recipient].

Unfortunately in a lot of these places you get movement of people. People don’t want to stay in the job all the time so they rotate around not just in the lab but also outside the support services and stuff so that can be a source of problems too and that’s what’s happening in [x location]. We’ve had Chemists keep coming and going there and we’re having to retrain them every time so it’s not like your typical bit of lab gear. It looks more complex than it really is and they’ve got to put some effort into doing it [18, Sender].

The implementation certainly at [x location] as an example went very smoothly so there’s a fair bit of pre-work that needs to be done before you do an implementation and I think the guys learned from what had happened in Australia [11, Sender].

...we’ve had other technologies brought into the Ops Centre and I’ve used those learnings from that particular one…[24, Recipient].

We can learn things that we’ll take away to other places as well because our practice is our best practices aren’t fixed in stone. They can change as we learn new things – our practices change and we modify the way we view things [7, Sender].

I know it [technology] has been updated with every new learning. If we discover something new it gets added into that best practice. So, yeah, I

| Making sure technology is producing [what it was expected to produce] |
| Understanding recipients' problems and engaging in troubleshooting |
| Post implementation support |
| Resolving issues |

Following up

| Providing support to recipients in a timely manner |
| Routine creation (i.e., sustaining knowledge into the system so it becomes daily operation, ongoing disseminating team support, & recipient training) |
| Routine disruption (recipient movement i.e., rotation or leaving the organisation, & poor role handover) |
| Learning (e.g., learning from first implementation, learning locally before implementing overseas) |

Learning based on learning from knowledge co-creation with recipients
mean going forward, new people coming in, you know, it’s a gathering of all the best practices [25, Sender].

- If you’ve got a complex strategy [technology] that you want [recipients] to employ and you know it will make money...[recipients will] only do this when it makes money for [them]...[7, Sender].
- You need real numbers and it needs to collate to it’s going to make some money so if you haven’t got that then you might as well not start so once you’ve got that concreted [31, Recipient].
- ...if you go to a particular Maintenance Supervisor and you can show that you can reduce these costs they would be interested. What makes it difficult is that it is fragmented [33, Sender].
- Well for the recipients it improves their business performance so it enables them to make more [x product] of better quality and at lower cost and that’s the ultimate win for the organisation...[3, Sender]

- ...they [sender team] should be experts on the subject matter...[19, Recipient].
- I think the key aspect was having the right people in the group. So we had people who were experts and had been around and understood the fundamentals from [sender team]...[29, Recipient].
- ...know your chemistry, know your science otherwise if they don’t do it right because of what you’ve told them it will come back and there will be problems [18, Sender].
- I think showing them that you know what you’re talking about. So it’s no good going out and just blah blah blah and then when someone asks you a question you go, I don’t really know. You’ve got to have the information to back-up what you’re saying [12, Sender].
- ...the level of confidence with which they [sender team] present their solutions [is important] and I guess their reputations amongst the general community count a lot and that’s why they’re careful in how they develop and present solutions to us and they’re not in too much of a rush...[34, Recipient].
- Yeah, spending time with the locations so being able to attend meetings, get on teleconferences etc and having the support at the location and that’s where also I think starting at an early stage so people have some confidence in the solution and in the team providing the solution so there’s credibility and there’s also support from the location that it’s the right time for that technology.

- I kind of think myself having the right people for disseminating the knowledge. Again you know, like we’ve just been talking about someone who can understand the technology and can communicate it clearly to other people and be able to, yeah, be the audience or, yeah, for the audience be able to present it in a way that they can understand [12, Sender].
- ...what you’re doing is not only trying to explain the technology and everything to them but you need to explain it in a manner that they can understand it because not everyone is going to get the complexity or pick up the complexity of the chemistry and so on that you’re trying to achieve [8, Sender].
- And someone who can deal with the different levels of people talking to them because not only do you have to listen to the [guy from the sender team] and talk to him but then you’ve got to talk to the Operator and explain to him what you’re doing so someone who has the ability to cross different levels of understanding. That’s probably the other key thing you’ve got to have because [sender team]are very technical. You can’t transfer that necessarily to an Operator directly. It has to go through someone who can speak their language so you need someone who can speak that way and across to the Operator [22, Recipient].
- ...sometimes people would prefer to have had the idea themselves and they don’t necessarily want to be told what to do. Eventually they accept it but that’s where the relationships come in and the interpersonal skills because you’ve got to get a relationship with people that’s good enough that they’re happy to be accepting the advice and to be accepting the knowledge transfer. You can’t force someone to learn something and that’s something that I’ve found a lot [7, Sender].
- The ability to engage with the stakeholders onsite to develop a good relationship with them because the sites are very busy and if they don’t value what you’ve got or they don’t value you then they’re not going to bother, they’re not going to waste their time actually doing anything so building rapport, having credibility is important and I guess they’re the key ones that spring to mind [10, Sender].

<table>
<thead>
<tr>
<th>Financial value</th>
<th>Knowledge value</th>
<th>Enablers of team DCAP</th>
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</thead>
<tbody>
<tr>
<td>Cost benefit</td>
<td>Ability</td>
<td>Disseminating team’s teaching skills</td>
</tr>
<tr>
<td>Subject matter expertise</td>
<td>Confidence</td>
<td>Breaking down something complex (abstract) into something simple</td>
</tr>
<tr>
<td>Ability</td>
<td>Teaching at different levels (based on recipients’ absorptive capacity)</td>
<td>Ability to build relationship with recipients</td>
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<tr>
<td>Disseminating team’s content knowledge</td>
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• …the Technologists [sender team] need to have the people skills to be able to communicate with the recipient. Often we struggle with understanding each other because you’ve got the Technologists in a theoretical world and my Engineers in a more practical world. We need people with the skills to bridge those two [23, Recipient].

• The challenge was I think for myself having a science background and knowing how to go out and be a salesperson and that’s slowly developing over the years. That for me I used to talk the science and say what the benefit was but still you need to be able to be like a used car salesman, you have to be able to convince somebody [12, Sender].

• …a good relationship is a facilitator. So you have the engineers in the plant working well with our group [sender team]; this is a huge facilitator [1, Sender].

• If people don’t like you they’re not going to listen to you. Now, I have a good rapport with people at site, and some sites better than others. So the sites where I have a good rapport, that’s what I’m quickest at executing. So yes, character is everything [23, Recipient].

• [Having] tight connection with the plants [recipients]... I think that’s actually the ideal situation – that’s just a recipe for success [33, Sender].

• Good relationships with the people onsite [recipients] is critical [10, Sender]

• …we had lunch together so [we] had a mingling of people, a fair bit of networking going on...[these types of things] work well [22, Recipient].

• …having good working relationships with all the guys so everyone of the people I’ve talked to I know personally and I’m friends with all of them and so that, if they rang me and asked me to do something then it would happen quite quickly and [x person] makes himself available to the site a lot as well. If he didn’t come down and go to those meetings and talk to the site I think that would be a problem but he did and I see that with other [sender team’s] projects as well that the people who do come down and talk to the site and are known to the site get things done a lot easier [22, Recipient].

• Letting people have an open mind. There were some aspects...that were imposed by certain people, but those things, whether they would be positive or negative, were basically detriments to the project in that we spent time on peripheral issues that didn’t need to be spent on, but it was people’s preconceptions of what had to happen when the project team wanted to go in a different way, it was imposed from management that, no, this is the way it’s going to be done; so working around some of those issues. If they had stayed out and let the project team go forward, I think we would have had a quicker, faster, better outcome on that [15, Sender].

• We’ve been told for a long time that we need to be open and we need to be open to new things and we need to be learning from each other. The whole best practice awards thing is structured that way. The people who get rewarded are those who – not the people who develop the new ideas but the people who stole them from others who have already proven them so that is considered to be the sort of thing we need to do and I think that does encourage people to put aside the not invented here attitude and accept practices from outside which really does help to – it just opens people’s minds a bit to implementing new things and doing new things and listening to how things are done elsewhere [7, Sender].

• As I said conservative. A lot of cross checking, a lot of due diligence and having said that we get our equipment to work better than I see people anywhere getting it. I used to think the biggest risk was that the people who get the equipment to work so it’s a very practical approach to running but that makes it difficult, it makes it slower. It makes the dynamics of bringing something new in slower [10, Sender].

• Getting that balance and getting a supportive environment in terms of a management structure that says, “Yes, we acknowledge that that level of risk is in place and will support it proceeding at that point” so the organisational support for understanding that the technology implementation does have risks. It is a change and that there needs to be consideration of how to manage any unexpected or even anticipated risks that need effort along the way but by having that environment it allows people to proceed more rapidly [4, Sender].

• ...if you’re doing a complex technology I think that would be one of the most difficult areas to work through, and that would delay the project a bit [15, Sender].

• [this technology is] complex and esoteric, that’s the problem…you’re predicting a result. It’s not a hard analytical result. You make a physical measurement and then you apply mathematical transformation and then you predict a series of results and no matter what measurement you make you will get a set of results so if you make a bad measurement you will get bad results and if you’re not attuned to that and watchful
for that and you don’t have a proper system of controls in place you will produce nonsense, a lot of nonsense in a short space of time and that’s what’s the most dangerous part of that technology [14, Sender].

- [this technology is] complex. It’s not trivial. Yeah, fairly advanced thinking and understanding is required to understand what’s involved. As I tried to explain to you each of those things that are shown up there interact with each other and have internal feedback as well so they have lots of recycle so you can’t think through – it’s not a linear process. You can’t logically think your way through everything. You need to go through some fairly abstract thinking processes to understand some of the steps that are involved yeah [10, Sender].

- ...the biggest constraint is competing priorities. So [this technology] is something new and it doesn’t necessarily provide a benefit immediately [12, Sender].

- ...we have no time, but a few things that we’ve done, we’ve done them, quick and dirty and all the information’s there, but just bang, bang hand, whereas you see other sites have more time and they’ve probably been able to think about things in more detail and in more technical detail...[30, Recipient].

- An easy answer would be critically give me 25 more people and we will do it better and the answer is that’s true but in reality that’s not going to happen most likely [2, Sender].

- I know at some locations where there are more production pressures and the Chemical Engineers in the area are more involved in the day to day troubleshooting, they do not get the time to be involved in the more strategic improvement activities and so the Engineers or the recipients need to be given time by their Supervisors and the Technical Manager to engage with [sender team] to clear the way and to facilitate the deployment of that technology...[23, Recipient].

- I think the biggest question is how much you invest in technology, how much budget we have to develop new things. If you start with an idea today, we calculate that...[it] takes a little bit – five years before you have that really generate borderline result [1, Sender].

- I think the biggest issue at the moment is the day-to-day survival...we’re in a bit of a cost crisis...the [industry] didn’t come out of the Global Financial Crisis as well as we thought...[12, Sender].

**Note:** The numbers at the end of the quotes are for identification purposes only.
### Appendix D: List of interview informants

<table>
<thead>
<tr>
<th>#</th>
<th>Position</th>
<th>Overall experience</th>
<th>Number of years/months in current role</th>
<th>Membership</th>
<th>Interview Intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Sender/Receiver</td>
<td>T1</td>
</tr>
<tr>
<td>1</td>
<td>R&amp;D Team Project Team Leader</td>
<td>15 years</td>
<td>4 years</td>
<td>Sender</td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>R&amp;D Team Principal Research Scientist</td>
<td>23 years</td>
<td>12 years</td>
<td>Sender</td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>R&amp;D Manager</td>
<td>22 years</td>
<td>3 years</td>
<td>Sender</td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td>Technical Manager Process &amp; Equipment Development</td>
<td>18.5 years</td>
<td>5.5 years</td>
<td>Sender</td>
<td>✓</td>
</tr>
<tr>
<td>5</td>
<td>Principal Research Scientist</td>
<td>23 years</td>
<td>5 years</td>
<td>Sender</td>
<td>✓</td>
</tr>
<tr>
<td>6</td>
<td>Lead Chemical Engineer</td>
<td>11 years</td>
<td>1 year</td>
<td>Recipient</td>
<td>✓</td>
</tr>
<tr>
<td>7</td>
<td>Lead Chemical Engineer</td>
<td>7.5 years</td>
<td>18 months</td>
<td>Recipient</td>
<td>✓</td>
</tr>
<tr>
<td>8</td>
<td>Project Team Leader</td>
<td>18 years</td>
<td>8 years</td>
<td>Recipient</td>
<td>✓</td>
</tr>
<tr>
<td>9</td>
<td>Technical Manager</td>
<td>28 years</td>
<td>12 years</td>
<td>Recipient</td>
<td>✓</td>
</tr>
<tr>
<td>10</td>
<td>Asset Owners Representative</td>
<td>33 years</td>
<td>11 years</td>
<td>Recipient</td>
<td>✓</td>
</tr>
<tr>
<td>11</td>
<td>Technical Manager</td>
<td>26 years</td>
<td>1 year</td>
<td>Recipient</td>
<td>✓</td>
</tr>
<tr>
<td>12</td>
<td>Technical Manager</td>
<td>27 years</td>
<td>5.5 years</td>
<td>Recipient</td>
<td>✓</td>
</tr>
<tr>
<td>13</td>
<td>Chemical Engineer</td>
<td>3 years</td>
<td>1 year</td>
<td>Recipient</td>
<td>✓</td>
</tr>
<tr>
<td>14</td>
<td>Capital Procurement Officer</td>
<td>10 years</td>
<td>5 months</td>
<td>Recipient</td>
<td>✓</td>
</tr>
<tr>
<td>15</td>
<td>Environmental Scientist</td>
<td>5.5 years</td>
<td>2.5 years</td>
<td>Recipient</td>
<td>✓</td>
</tr>
<tr>
<td>16</td>
<td>Asset Owner Representative</td>
<td>14 years</td>
<td>11 years</td>
<td>Recipient</td>
<td>✓</td>
</tr>
<tr>
<td>17</td>
<td>Asset Owner Representative</td>
<td>9 years</td>
<td>2 months</td>
<td>Recipient</td>
<td>✓</td>
</tr>
<tr>
<td>18</td>
<td>Environmental Scientist</td>
<td>7 years</td>
<td>5 years</td>
<td>Recipient</td>
<td>✓</td>
</tr>
<tr>
<td>19</td>
<td>Team Leader Operations</td>
<td>15 years</td>
<td>11 Months</td>
<td>Recipient</td>
<td>✓</td>
</tr>
<tr>
<td>20</td>
<td>Project Engineer (Project Team Leader for External contractors)</td>
<td>9 years</td>
<td>4 months</td>
<td>External Contractor</td>
<td>✓</td>
</tr>
<tr>
<td>21</td>
<td>Mechanical Engineer</td>
<td>1 year and 8 months</td>
<td>8 months</td>
<td>External Contractor</td>
<td>✓</td>
</tr>
<tr>
<td>22</td>
<td>Contractor Coordinator Team Leader/Contractor Service Specialist</td>
<td>4 years</td>
<td>2 years</td>
<td>External Contractor</td>
<td>✓</td>
</tr>
</tbody>
</table>
Appendix E: Study 2 interview protocols

Demographic Questions

1. Can you tell me a little about yourself –what is your job title in your current position at [this organisation]?
2. What are your key roles and responsibilities in your current position?
3. What is your role in the current project?
4. What Department do you work in?
5. How many months/years have you worked at [this organisation]?
6. How many months/years have you worked in the current position?

Interview Questions (T1)

1. In Layman’s terms, can you give me some background information on the technology, e.g., what does it involve?
2. Is the technology new to your industry or in the world? (Is the technology highly tacit?)
3. How many people are involved in the technology? What are their roles/responsibilities? (Can you please list the names of the people involved in the project so I know who to interview)
4. How has it progressed along the Stage gate processes? What are the key milestones?
5. Who makes decisions on Stage Gate and when to proceed to the next stage?
6. Do you hold regular meetings regarding the technology? (Who are involved e.g., senders/receivers? What topics/issues do you discuss?)
7. Does co-creation take place in those meetings? (In what way does it occur? How does it help? Who are involved, i.e., senders and receivers? Does it occur between senders or between senders and receivers? Do you find it easy or difficult to reach to a consensus?)
8. Who are important knowledge sources for your project? (Do you have access to knowledge/information sources (e.g., experts, reports/spreadsheets) relevant to your project when needed?)
9. What are barriers and facilitators of the project? (What has worked well and what hasn’t worked well?)
10. What are potential key success factors of this project?
11. What are some of the key challenges ahead of you in this project?
12. What are your future plans in terms of co-creating technology? (Will you hold regular meetings, undertake lab tests, etc? (Who will be involved, and what topics/issues will you discuss?)

13. If there is an area that needs to be addressed in order to improve future knowledge co-creation, what would it be?

14. Would you like to share anything else that I haven’t asked you?

**Interview Questions (T2)**

**Schedule/time pressures**

1. How is the project progressing? What are the key milestones?

2. Some tasks that needed to be actioned as recorded in meeting minutes were not completed on schedule. What were some of the factors that caused a delay in the schedule?

3. With regard to the project schedule, do you think that you are ahead or behind the schedule? What can be done to ensure tasks are completed as per your project schedule?

**Key reviews associated with the project**

1. Recently, some reviews (e.g., HAZOP, design review) were conducted. What outcomes were generated out of these reviews? (Were some major changes/modifications made to the technology design? Who suggested changes/modifications to the technology design?)

2. What department(s) did the attendees in the reviews represented? (What contributions did attendees make?)

**The prototype**

1. Given that the technology is a prototype, what issues, risks or concerns do you foresee?

2. What strategies are in place to deal with the issues/risks/concerns as they may arise in future, e.g., after commissioning?

**Presence of three parties in the meetings**

1. What unique contributions do the three parties—external experts, recipients/customers, and R&D team in the meetings make to the technology project?

2. In the weekly project meetings, does everyone feel comfortable giving suggestions, sharing concerns or disagreements? (Are there instances where people are cagy and not engaged in discussions?)

3. Do you think co-creation occurred in the technology?
Role of artifacts in collective sensemaking

1. In the past few weeks, (particularly in the review meetings) drawings and 3D models were shown on the projector. In what way do you think did the drawings/3D models help you in understanding about the design of the technology? (Did the drawings/models clearly show/capture all the necessary design details about the technology? Were your suggestions for changes captured in the 3D models?)

Other questions

1. What are barriers and facilitators of knowledge co-creation in your project team? (What has worked well and what hasn’t worked well so far?)
2. What are potential key success factors of this project?
3. Are there any major issues/roadblocks that are impacting the progress of the project? (What does your team do to resolve these issues/roadblocks?)
4. Looking into future, what key milestones do you have regarding the project? (Undertake detailed design, construction, commissioning, etc?)
5. If there is an area that needs to be addressed in order to improve future knowledge co-creation, what would it be?
6. Would you like to share anything else that I haven’t asked you?

Interview Questions (T3)

Commissioning phase

1. I am interested to know what the process of commissioning involves and how it is currently progressing? (When did commissioning start, and when will it be completed? Who are the key people involved in the commissioning process?)
2. Thinking of the schedule and delivery of the project, was it on time and on budget?

Knowledge co-creation outcomes

1. I would like you to evaluate the qualities of the finished product (the technology). What qualities does the technology have given that various parties i.e., R&D team, recipients, and external contractors contributed in their areas of expertise?
2. Based on my observation, and findings from previous interviews, the process of knowledge co-creation led to co-created knowledge with the following four qualities (I’ll explain them one by one):
Multifacetedness (multidimensionality—the extent to which the various parties i.e., R&D team, recipients, and external contractors see things from different angles). What do you think of this, and can you share an example of how this played out in the project?

Utility (the quality of knowledge being operable/useful as a result of incorporating site’s/recipients’ practical knowledge/experience. What do you think of this, and can you share an example of how this played out in the project?

Shared ownership (feeling a sense of ownership of knowledge and commitment to use it because everyone’s ideas/suggestions were taken into account, and that everyone was part of the knowledge co-creation process). What do you think of this, and can you share an example of how this played out in the project?

Enhanced quality (meaning that knowledge that is co-created by teams in their areas of expertise is of better quality than the form of knowledge that is developed in isolation). What do you think of this, and can you share an example of how this played out in the project?

3. What other outcomes did the project team achieve by having a mix of experts in the room?

4. What were the key factors that contributed to the success and effectiveness of the project?

5. What were the key factors that constrained the success and effectiveness of the project?

6. Would you like to share anything else that was key to the success of the project?
<table>
<thead>
<tr>
<th>Representative Quotes</th>
<th>1st Order Concepts</th>
<th>2nd Order Themes</th>
<th>Aggregate Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Everyone has listened to each other and I always say to people listening is a skill and it is a skill and without listening you don’t get communication so it’s that to and fro that’s been good I think [11, Recipient].</td>
<td>My opinion was valued</td>
<td>Listening to recipients</td>
<td>Perspective taking</td>
</tr>
<tr>
<td>I think the meetings work well. It allows everyone to raise concerns with everyone in the room so everyone has a buy in and everyone can hear the concerns as they come [13, Recipient].</td>
<td>Allowing everyone to raise concerns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Well being realistic early so be realistic with our schedules and timelines. You see sometimes - and sometimes it’s a result of pressure from above. Yes, set realistic timelines but realistic achievable timelines because sometimes we put pressure on ourselves by not allowing enough time to do our job well [15, Recipient].</td>
<td>Giving a realistic timeline</td>
<td>Empathising</td>
<td></td>
</tr>
<tr>
<td>Some of the [recipient team’s] resourcing on this project has been overloaded and I have flagged this to others over a period of time and those individuals have flagged it upwards and it’s been resolved but it’s taken a period of time for that to be resolved. I don’t think it’s necessarily a reflection on the individual’s capability[4, Sender].</td>
<td>Understanding workload</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I think what is being done is really engaging with the stakeholders very clearly in terms of the objectives and deliverables of the project and making sure that the customers and stakeholders understand what might be generated by the project [8, Sender].</td>
<td>Having shared objectives in terms of deliverables</td>
<td>Aligning objectives</td>
<td>Collective sensemaking</td>
</tr>
<tr>
<td>So we have that sort of interaction in making sure we’re heading down the right path in terms of the road maps…[10, Sender].</td>
<td>Being aligned in achieving common goal</td>
<td>3D models</td>
<td>Utilising material artifacts</td>
</tr>
<tr>
<td>The 3D models are excellent. It gives you a real tight look at how the plant is going to be set up. It helps to get a better understanding as to where things fit and how things will operate [9, Recipient].</td>
<td>Isometrics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>…when you don’t have things like isometrics you can leave yourself vulnerable to things that you can’t see in those reviews or a lack of understanding of how those things work [1, Recipient].</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>We agreed on Option 2 (2 nozzle option). It’s recorded in the minute that &quot;decision on 2 nozzle outlet completed” [archival data/observation].</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>As you progress through that basically you need to get signoff from the relevant people…[1, Sender].</td>
<td>Signoff from relevant people</td>
<td>A sense of equality among team members</td>
<td>Psychological safety climate</td>
</tr>
<tr>
<td>They [team members] are all open and they’re all accepting of input from each individual. Yeah, I think it’s actually quite good because there’s no animosity there or unappreciation or anything like that [9, Recipient].</td>
<td>Having open dialogue</td>
<td></td>
<td></td>
</tr>
<tr>
<td>...the feeling that you’re in an environment that you can express your ideas or ask questions without fear of judgment perhaps. Definitely [a lack of] those sorts of things will constrain knowledge co-creation and sharing [6, Recipient].</td>
<td>Expressing oneself without any fear of embarrassment</td>
<td>Not having senior people (e.g., immediate supervisors) in the room</td>
<td>Agency of effective leadership</td>
</tr>
<tr>
<td>If some of the Senior Managers were showing up at this table on a weekly basis I think that we’d probably see a less open, less robust discussion because we wouldn’t want to say something in front of our Manager that was out of line or could be construed as out of line [11, Recipient].</td>
<td>Not shutting people down</td>
<td>A bit of banter to lighten the mood</td>
<td></td>
</tr>
<tr>
<td>Well, the first thing is it’s well led. It’s well led by [x] because it starts from the top so he’s created this let’s call it a comfortable environment, okay so he’s helped create that and because he’s created that everyone – so he’s given a bit and everyone has given some back…[1, Recipient].</td>
<td>Role clarity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>We’re always having a bit of a laugh down there so I think it goes a long way to helping the team work together [14, Contractor].</td>
<td>A bit of banter to lighten the mood</td>
<td>Having the right people in the right roles</td>
<td></td>
</tr>
<tr>
<td>Everyone has had a defined role so it has been a collaborative effort but ultimately importantly people have had defined roles… [5, Recipient].</td>
<td>Everyone understood what their role was</td>
<td>Preparation work before meeting</td>
<td>Formalisation of meetings</td>
</tr>
<tr>
<td>Make it – it’s your project so giving people not just the drive but the responsibility so that they are the person who is responsible for it and therefore they’re actually going to take ownership [7, Recipient].</td>
<td>A bit of banter to lighten the mood</td>
<td>Role clarity</td>
<td></td>
</tr>
<tr>
<td>I think the fact that everyone comes into that meeting with a fair bit of pre-work done for anything that they need has been very good so it means you don’t have to go through the intricate detail to get to where you need to be… [7, Recipient].</td>
<td>A bit of banter to lighten the mood</td>
<td>Role clarity</td>
<td></td>
</tr>
<tr>
<td>As soon as you write you are responsible for this so this is your name and this is the date, there is more impetus to actually go and make sure</td>
<td></td>
<td></td>
<td>Minuting meetings</td>
</tr>
</tbody>
</table>
that you do it because it stays on the minutes and people see it. If you’re not doing it people are knowing that you’re not doing it so I think it’s a good process to use yeah, definitely [2, Recipient].

• there will be key technical people [from disseminating team who] will continue to be involved in that process to ensure that the design still maintains the integrity of the original intent and research assumptions so it’s very clear ...[12, Recipient].

• The role of [disseminating team] I think is to bridge the gap between the academic and the practical to go and have a look at, “Well what is out there?” and do the literature surveys, do the site visits, know what is happening in other industries and look at applications of that different technology into our - so they’re the link for us to go and review new technology and different technology and different processes [12, Recipient].

• I believe you need to involve us [recipients] from the start because we [recipients] can often define the problem to a finer point” which will enable them to go and target better the technology [12, Recipient].

• For us [recipient team] the contribution [we made] was around design layouts, how do we want it to look, what equipment do we want? Where do we want those valves to be? Where do we want these pumps to sit and that sort of contribution so it wasn’t from a technical aspect, it was more around the operability of the plant [10, Recipient].

• Things like [E], that one wouldn’t exist without the customers because they haven’t created the technology but what they’ve done is created the pool for the technology and helped us [disseminating team] and themselves to understand the business case for that technology and to do that they’ve got to understand what we’re doing because the whole thing isn’t about just the little process that we’re going to add, it’s how that is integrated into the refinery to make it more efficient [10, Sender].

• Everything else has been written into a process design criteria (PDC) and we’ve engineered it and there’s little bits and pieces but essentially, it’s not knowledge co creation, it’s engineering to a specification that’s been given to us by the client [5, External Contractor].

• ...you just basically give that to a construction company who does the design and construction on your behalf and there are ways of speeding it up, but that’s not the typical process for here in the refinery, but I think we’re being pushed a little bit more that way to try and deliver these things faster [4, Recipient].

• Everyone wants everything squeaky clean, no risk but in a prototype and a technology development there’s inherent risks that until you do it you don’t know the full scale [7, Sender].

• [This is] a company [that] is traditionally risk-averse so there are some competing behaviours there and I think our inherent mode of operation is to try and understand everything 100% before we move on and in this sort of project it’s not possible and I think that’s where the challenge has been [2, Recipient].

• ...it is a new process so it’s a full-scale prototype so that in itself, not having been done before and not having been prototyped before, going straight to a full-scale has an inherent high level of risk within it [4, Sender].

• ...anything that happens in [mining] is that everything is cyclic and everything interconnects...[13, Recipient].

• I mean with regard to those risks we look at defining the risk, what we have currently in place from a design perspective to mitigate the risk; what controls we would need to have should the risk occur and then the impacts whether that event occurred would have so we have quite already a very formalised structure to assess the risk and again that whole risk assessment process goes through a similar sort [4, Sender].

• We’ve done a lot of lab work so if we’ve come up with a theory that this could happen so we did some significant lab work around the heat generation. We’ve done lab work around the [x technology] [7, Recipient].

<table>
<thead>
<tr>
<th>Main technical source of knowledge</th>
<th>Disseminating team: Strategic/technical knowledge</th>
<th>Knowledge diversity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge the gap between theory and practice</td>
<td>Define problem to a finer point</td>
<td>Recipient team: Operational knowledge</td>
</tr>
<tr>
<td>Critique ideas</td>
<td>Provide operational guidance</td>
<td></td>
</tr>
<tr>
<td>Engineering</td>
<td>External contractors: Specialised knowledge</td>
<td></td>
</tr>
<tr>
<td>Designing</td>
<td>Everything to be low risk and proven</td>
<td>Organisational risk aversion</td>
</tr>
<tr>
<td></td>
<td>No framework within the management to accept risk</td>
<td>Barrier; risks and uncertainties</td>
</tr>
<tr>
<td></td>
<td>Not knowing everything about the technology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Knowledge tacitness</td>
<td>Risk mitigation</td>
</tr>
<tr>
<td></td>
<td>Safety reviews to minimise risks</td>
<td>Conducting tests</td>
</tr>
</tbody>
</table>

*Note: The numbers at the end of the quotes are for identification purposes only.*
Appendix G: Study 3 interview protocol

**Demographic Questions**

1. Can you tell me a little about yourself –what is your job title in your current position at [this organisation]?
2. What are your key roles and responsibilities in your current position?
3. What is your role in the current project?
4. What Department do you work in?
5. How many months/years have you worked at [this organisation]?
6. How many months/years have you worked in the current position?

**Interview Questions**

**Background**

1. In layman’s terms, can you explain what the technology involves?
2. What stage in the Stage Gate processes is the technology* currently in?

**Implementation**

1. I would like to ask you to evaluate the nature of the technology* in terms of being explicit or tacit. (Explicit knowledge is defined as one that can be easily expressed in words or codified in documentation. Tacit knowledge is one that is difficult to be expressed in words or codified in documentation. To what extent is the technology codified in documentations? How easy/difficult do you think did customers find it when it was implemented? How did the nature of the technology* influence the implementation process?)
2. What training was carried out as part of the implementation process? (Who provided the training? Sender or recipient, or both? How long was the training? Who received the training? Is there still on-going training?)
3. What documentation was provided to customers when rolling out the technology*? (e.g., training documentation, operation & maintenance guidelines, SWIs, etc? How are these working?)
4. I would like to know the level of customer involvement in the development and implementation process. (What contributions did customers make, and how did their knowledge help R&D team?)
Routinisation

1. How is the technology* currently operating? (Is it being routinely used by customers? Are customers self-reliant and have gained necessary knowledge to operate and maintain the technology*? Have you experienced any issues post implementation e.g., has the technology* broken down or not used by customers? What caused the break down?)

2. What support mechanism is available within R&D team in instances where the technology* is out of order? (Who is the “go to person” when there is a need for support?)

3. What mechanism is currently in place for maintaining/sustaining the technology* so customers keep using it? (e.g., Is there on-going training? Regular R&D team visits of site?, etc)

Learning

1. I am interested to know what lessons you have learnt from rolling out the technology* that can be fed into improving future roll out? (e.g., by lessons I mean technical understanding, & understanding about effective way of rolling out the technology*—e.g., better sender-recipient knowledge co-creation, etc? Can you give me some specific examples of these?)

2. How has the technology* evolved post implementation? (Has the technology* changed due to feedback from users? How has user experience changed/improved the technology*? Is there sender-receiver collaboration to further refine the technology* post implementation? What are the barriers/facilitators for this?)

3. Can you share an example of how the technology may change in future based on the lessons learnt from previous transfers? (e.g., feedback received from customers in terms of what functionality the future technology may have, etc)

4. How has the evolution of technology changed the way customers perform their day-to-day work? (Has it improved the way they do their work? Has the improvement in technology made their job more convenient? Do customers put in less physical effort to perform their work because of improvement in technology?)

Other Questions

1. What were the key barriers and enablers for effectively transferring the technology*—so that it is routinely used by customers? (What worked well and what didn’t work as well?)

2. If there is an area that needs to be addressed in order to improve the way the technology* is rolled out so it can be routinely used by customers, what would it be?

3. Would you like to share anything else that I haven’t asked you?
Appendix H: List of interview informants

<table>
<thead>
<tr>
<th>Inf #</th>
<th>Position</th>
<th>Overall experience</th>
<th>Number of years in current role</th>
<th>Membership</th>
<th>Technology*</th>
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<tbody>
<tr>
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<td>Sender/Receiver</td>
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<tr>
<td>3</td>
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<td>7.5 years</td>
<td>Sender</td>
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<tr>
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<tr>
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<td>10 years</td>
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<td></td>
</tr>
<tr>
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<td>5 years</td>
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<tr>
<td>7</td>
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<td>9 months</td>
<td>Sender</td>
<td>A</td>
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<tr>
<td>8</td>
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<td>10 years</td>
<td>4 years</td>
<td>Recipient</td>
<td>B</td>
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<tr>
<td>9</td>
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<td>5 years</td>
<td>Recipient</td>
<td>C</td>
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<td>7 years</td>
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<td>2 years</td>
<td>Recipient</td>
<td>F</td>
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<tr>
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<td>1 month</td>
<td>Recipient</td>
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<td>15 years</td>
<td>Recipient</td>
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<td>6 years</td>
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<td>11 years</td>
<td>Sender</td>
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<tr>
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<tr>
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<tr>
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<td>2.5 years</td>
<td>Recipient</td>
<td></td>
</tr>
</tbody>
</table>

*Names of technology: A, B, C, D, E, F, & G
All**: All technologies
Inf: Informant
### Appendix I: Representative quotes for effective knowledge integration trajectory (knowledge co-creation aggregate dimension)

<table>
<thead>
<tr>
<th>Case</th>
<th>Representative Quotes</th>
</tr>
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</table>
| A    | • I think the lesson was to bring people on the journey by spending a bit of time with them, so identifying who the one person is who needs to be the champion at the site and just spending the time with them to make sure that any concerns are heard and understood because the alternative is if you can’t convince them that this is a good thing and you’re not giving them the time that they need to buy into the project they can end up, you know, white anting the project and being destructive [1, Sender].  
• …we [disseminating and recipient teams] worked together to get a package that worked because the technology is one thing but the implementation into an operating environment is another so you’ve got to get the two elements to come together so that it actually works so it’s effective and robust… [10, Recipient].  
• I think some element of co-development. That’s probably the best way and also understanding what the customers’ needs are and understand if you can deliver on something that they’re pulling for so if the refineries are having a common problem or a significant problem, having that technology that they want will mean that it will stay embedded. If they don’t want it and you give it to them they won’t do anything with it even if it’s of benefit [10, Recipient].  
• This one [technology] was very much a collaboration with the site on that one because it really was the site drove the need to have a technology. So they had a problem, they needed a solution to it and they come to the R&D team, come and say here’s ideas around it, like that, and they go, yes, no, yes, no, yep, okay, let’s go work on this one. So I don’t think you could do much more than what was done in this one [3, Sender].  
• Oh, you can’t implement it without the site, because the site lets them know what’s actually going on in the areas. You need to have them involved to be able to put that [technology] in. So yeah, when it comes to implementing it they are absolute part of the process all the way along. So developing the technology itself, customers call and they say we want this technology to do this, or we say we have this technology, how could it benefit you, and the development side of it might be more of out just within the R&D team. Once you get to a point of trying to put it in on a site you have to have the ground level knowledge of what’s going on in the site to be able to actually get them in there [3, Sender]. |
| B    | • bring them [recipients] along. The best outcome would be that you get the tech managers aggressively asking you to be first, so yeah, “I want that and I want it as soon as you’re ready. I’ll sponsor the first prototype,” and we do get that, particularly if there’s a refinery that’s suffering pain in that area and we’re presenting a potential solution, you’ll often get their engagement [2, Sender].  
• We absolutely owned [B technology] because we were putting it in. We were driving the implementation rate and we were having to solve the issues that were coming up. If the R&D team [disseminating team] had come in and just turned it on, we wouldn’t have done all that learning and I suppose we wouldn’t have developed that confidence in the process either so I think you absolutely need a champion at the site for it to be sustainably installed [6, Recipient].  
• The big enabler was that we [recipient team] had a problem. If we weren’t having any issues, we wouldn’t have even been talking about it. We still wouldn’t be talking about it.  
• We were solving a business problem. I suppose it happened to come along at the right time. If we had talked to [Jason] and they hadn’t done the work or it wasn’t ready to go that would have been a problem [6, Recipient].  
• I think it’s about thinking about the customer use so [disseminating team] thinks about can we physically measure this? How do we measure it? Okay great and they build us a machine and it measures it. Great, it measures it and that’s nice but how do I make it correlate with my plant so if the machine says, “That’s 30” and my plant says, “No, that’s 40”, how do I make the two calibrate? How do I make them agree with each other, so the customer need out of that piece of equipment is consistency in the numbers, so they’ve made a technically accurate machine? They technically believe in its capability but then to actually use it I need to trust the number that it’s spitting out and it needs to agree with all my previous numbers because I’ve been measuring [this] for the last 30 years using lab equipment, I need that number to agree with those numbers so that I can seamlessly keep using it so when I put it into control it just seamlessly works so yeah, that requires input from the customer so that consideration from the R&D team of how is it going to be seamlessly transitioned in with the history of [x location of recipients] I suppose is where that [piece of technology] comes into effect [7, Recipient]. |
| C    | • …so definitely having people involved from as early on as possible helps for that co-creation and ownership but yeah, I think the ongoing support and allowing site to feed back what they’re seeing and whether it’s meeting their expectations means that they’ve got ownership in that side of things and we’ve got ownership in ensuring that their needs are met by being involved and responding to their requests on a regular basis so I think the communication between all three is quite good for this project anyway and most people are present from all three parties as well so that helps [8, Sender].  
• [Involvement of recipients was] mostly about the physical installation, making sure what kind of valve was going to be put in, the location, the ability to [address recipients’ needs] as a requirement – these more practical concerns around the physical design of the project I think would have been the biggest factor [9, Recipient]. |
| E | • Now, one of the things that we try and do really well here is the concept of stakeholder buy-in. Now, in my mind, stakeholder buy-in well, it first involves identification of your stakeholders like who are the people who are going to support this at the early phase? You need people to bless your efforts. People important enough in the technical field and the operations field to give you a chance to either succeed or fail – one or the two and that’s where the identification of stakeholders becomes very important and then engaging with these stakeholders and keeping them informed and proving to them offline before you even put something online, proving to them offline that look, we tested this, we generated the curves, the data. This is what it looks like. This is what you have. This is what you are going to get so you’re building that confidence in them upfront so that’s even before you’ve done anything in the plant [14, Sender].  
• The role of site is key to this because they are the customers. Ultimately, they need to buy that solution. They need to digest that information. They need to approve that information or approve that solution delivery, so they are the key person and I think getting their feedbacks, getting their buy-in is a must for any project [15, Sender].  
• …we can see in advance what should be happening but it takes delayed time to get there or it takes too long to get there so we’re always having to run things maybe in order to try and pick that up a bit and then putting it back into the program so the program catches up. Sometimes it’s delayed and things like that so sometimes programs are a bit slow to pick up what it should be doing. Sometimes the [E technology] doesn’t foresee what’s going to happen in the future as quick as it should so sometimes we’re on the back foot that way [27, Sender]. |
| G | • They have to want it I guess. Yeah, like we’ve been saying all along, it’s like if the customer doesn’t want it, it’s never going to get in place so yeah, it’s a customer-driven need and then you have to understand their systems so if you’re going through and putting something in there it has to be embedded into whatever system they’ve got going through there and then it can stay. If it doesn’t get into the daily systems and if it doesn’t get into somewhere in either handover documents or anything else, then it will disappear over time. It has to be in there [18, Sender].  
• Yeah, the feedback we get is that the [technology makes] it easier to remove the scale. They still would like it that the scale doesn’t form in the first place and that’s the strongest feedback we get is we need to come up with a technology that stops the problem in the first place instead of making the problem easier to fix [19, Sender].  
• The operators, certainly in [Australia], a lot of them have a small business on the side, outside of [this organisation]. They are leaders of community organisations. They are engaged outside of work, working at a very high level. They’re not mushrooms when they come to work but if we treat them like that so I’d like to think that when we’re implementing change, we spend a lot of time in the control room or in the classroom, pseudo classroom talking to the operators about why this is important, how it’s going to change, what’s the outcome going to be; what you guys should be looking for at an operating level so that they get some ownership of it as well but not necessarily talking to them solely about what the business case is but more of their investment in what they’re going to see different operationally [20, Recipient]. |
## Appendix J: Representative quotes for ineffective knowledge integration trajectory (knowledge co-creation aggregate dimension)

<table>
<thead>
<tr>
<th>Case</th>
<th>Representative Quotes</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>• I think given we’ve had the technology for 20 years it was very difficult to get it. We didn’t know why they didn’t want it. We didn’t know why they weren’t doing it. It was literally a case of we had it, they didn’t want it, what do we do? Now, I used to be the customer – hence they called me in so I had insight as to how they thought and I’d say the biggest – yeah, the biggest problem was just to get them to realise there was a business case so it probably took, well it took a year to get them to try it and another year to get them to play with it but once they had it, they were never giving it up [5, Sender].</td>
</tr>
</tbody>
</table>
| D    | • Well because at the moment they don’t want to run it so it’s about listening to their gripes about why they don’t want to run it, changing things to make them happy because they are the people that turn it off so if they say, “I don’t like running it because every time I have to take manual action, it’s more effort”. We have to look at why it’s more effort and if we can do something to keep them happy. It’s not necessarily to make it technically perform better but it’s just to make their life easier or to redress some of the gripes they have. It’s not about technical performance. It’s about making them happy basically [13, Sender].
  • The feedback that you as a CA [control attendant] gave to the support network locally was taken on board and made it a lot better because it was, it was quite dumb to start with and quite inefficient but the local support and the feedback from these guys together has made what we’ve got today which is very useful and very efficient and very productive [24, Recipient].
  • Well, I mean except for [x location] which like I said has its issues, everywhere else, like the utilisation is very very high and we don’t have any issues so probably [y location] is the best. Well I would say [y and z locations] the best because [y] was the last project we did and [z] like I said, we went in and made some modifications or improvements to get it working better so those are probably the two that have embedded the best but in general except for [x], it’s done very well [13, Sender].
  • We weren’t involved in the initial setup or the initial designing of it. We’ve only been involved because of feedback so that they’re able to improve it but there were no people at our level involved in the initial design or anything [23, Recipient].
  • So no. Actually, when they first brought it in, it actually scared a lot of people and I’ve got to admit I was one of them because I’m thinking to myself they’re automating our job. Our job is already fairly automated but they’re automating it more. They’re getting to the stage where they actually don’t need – it wasn’t until they went to great pains to explain that “Hey, we’ll still need people to run the place”. I think if people on our level had been involved in the initial design or sat down in a room and said, “Look, this is what we plan on doing” then maybe but we had none of that. We were just basically – dumped on us one day. “We’ve got an advanced [technology] coming. It’s going to run really great” [23, Recipient]. |
| F    | • That parcel of work was then given to an external contractor to build and a lot of these processes were done in isolation of [recipients] so as a customer who was supposed to run this process, we were given a package, a constructed installation with very few instructions so it’s like getting a – let’s say you’ve got a box of Lego to make a Darth Vader but you haven’t got many instructions to put it together, so we had a few presentations. We had some very sketchy details in terms of how it worked but I’d argue that there was very little involvement of us in trying to develop the technology, design it or run it until right at the very last minute so all of a sudden we were given this process that we had to commission and work and we really didn’t know what it was supposed to do or how it was supposed to work so the learnings for me is ensure that we get involved in the development of the process from the start so that we can only get our process modelling people involved, get our Area Engineers involved and get everyone understanding what the technology is supposed to do, what we’re trying to achieve and how it works so that then when we do come to implement it, the site has already got a foundation of understanding; they’ve been involved in writing the procedures, they’ve been involved in designing it and they’ve been involved in writing up the foundation and understanding of the work so therefore, it’s a lot easier when we come to turn it on and implement the process we’re able to take ownership and I think that’s part of it. If you’re not engaged from the start and you’re given something else to go and implement and run, it’s just more work that you have to do and you don’t have the time to understand with very little notice what the technology is supposed to do or how to run it [16, Recipient].
  • I think all the earlier stage ones, that was definitely in-house and the [x location] one, although it would have been presented to them I don’t think they had much involvement at all to be honest…possibly for this one, this is something where a lot of learnings can come from how it was deployed. The timeframe may have played into it as well in terms of how quickly it needed to be done [17, Sender]. |