Abstract

Novel technologies are based on fundamentally different and often new knowledge and resources. Research has shown that despite being the source of such breakthrough innovations, incumbent organizations often struggle to capitalize on these opportunities and successfully deliver novelty to the marketplace. As such, the challenge of incumbency has garnered much scholarly attention. While prior scholarship has acknowledged the important role played by middle and operational managers, it has failed to address how these managers should communicate novel technological opportunities to engender the attention and support from key decision-makers for these courses of action. Similarly, while the extant literature has offered a number of cognitive and structural reasons why incumbents are (not) able to pursue novel technological opportunities, scholars have only recently begun to consider the role that emotion plays in this process.

To better understand how managers communicate novel technological opportunities to decision-makers, and what role emotion plays in the pursuit of novel technological opportunities in large, established organizations, I have conducted a 24-month case study of an incumbent firm as it pursues novelty. The firm, TechCorp (pseudonym), is a large multi-technology incumbent business, attempting to commercialize Quantum Key Distribution (QKD), a particularly novel form of security technology. Using rich, descriptive qualitative methods including in-depth interviews, observations and document analysis, my research suggests that the pursuit of novel technological opportunities in incumbent organizations is a highly affective process, characterised and propelled forwards by distinct forms of fear. Accordingly, this study develops a process model which captures the emotional dynamics that may emerge as incumbents pursue particularly novel technologies, and suggests how these emotions may be linked to the cognitive and communicative processes of managers, which may influence how incumbents are able to pursue novel technological opportunities.

Three main contributions are provided by this thesis. First, this thesis reconceptualizes fear in the incumbent pursuit of novelty by suggesting how it may help to propel technological opportunities forwards, and by highlighting how different forms of fear exist. This more contingent perspective represents a departure from the extant literature, which largely portrays fear as detrimental to attempts to innovate. Second, this thesis suggests that to gain the attention and support of key decision-makers, middle and operational managers may communicate novel technological opportunities in terms of, or to evoke, negative emotions like fear, rather than positive emotions as prior scholarship has suggested. Third, this thesis illustrates how decision-makers may experience emotional ambivalence towards novel technologies, which can cause indecision as a consequence. However, indecision may paradoxically aid novel technological opportunities in incumbent organizations by providing time and space for them to develop. In this manner, this thesis elucidates the emotional factors that contribute to indecision, and advances a more positive perspective on ambivalence and indecision in the process.

Nothing to fear but fear itself: How emotion can affect the pursuit of novel technological opportunities in incumbent organizations

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

Abbreviation	Term
R&D	Research & Development
CSU	Customer-Serving Unit(s)
TM	Top Manager
MM	Middle Manager
OM	Operational Manager
QKD	Quantum Key Distribution
PQC	Post-Quantum Cryptography

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Author's Publications

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1 Introduction

Innovation and the pursuit of novelty has been revered as the 'lifeblood' of organizations (Tushman and Anderson, 1986), helping to ensure the long-term survival and prosperity of incumbent organizations by enabling them to adapt to environmental changes (March, 1991). However, research has shown that despite often being the source of novel technological breakthroughs, incumbent organizations frequently struggle to capitalize upon the market opportunities afforded by such innovations, despite being well-placed to do so (Hill & Rothaermel, 2003; Eggers & Park, 2018). The literature is replete with examples of incumbents who have surrendered a market leading position on the basis of their inability to innovate and pursue forms of novelty, including the likes of Blockbuster (Raffaelli, Glynn & Tushman, 2019), Smith Corona (Danneels, 2011) and Polaroid (Tripsas & Gavetti, 2000). Nonetheless, there are also examples of incumbents who *are* able to innovate and pursue novelty, such as Netflix (Raffaelli, Glynn & Tushman, 2019), Google (Garud & Karunakaran, 2018) and Vodafone (Thomond et al., 2003). This begs the question: why are some incumbents able to successfully innovate and pursue forms of novelty whilst others cannot?

Consequently, the challenge of incumbency has received much scholarly attention, leading to the identification of a number of structural and cognitive factors that are consequential for incumbents and how they may pursue forms of novelty and innovation. Research suggests that the existence of slack resources (Cyert & March, 1963), spare absorptive capacity (Cohen & Levinthal, 1990), possession of complementary assets (Tripsas, 1997) and a willingness to cannibalize existing products and service offerings (Eggers & Kaul, 2018) are factors that can facilitate incumbent innovation and adaptation. Conversely, inertial forces associated with existing capabilities, resource commitments, routines, and cognitive frames may preclude incumbents from exploring and pursuing novel technologies and solutions (Leonard-Barton, 1992; Christensen & Bower, 1996; Kaplan, 2008; Tripsas, 2009). In this respect, a major issue is the fact that top managers, who are located in the corporate centre of the organization, are constrained in their ability to form adequate cognitive representations of the environment in order to respond to novel technological opportunities, owing to their structural distance from the environment (Regnér, 2003; Gavetti, 2005) and commitment to the status-quo (Christensen, 1997).

Top managers, therefore, often rely on the cognitive capabilities of more peripheral middle and operational managers to draw their attention to emerging technologies, whose structural proximity to the environment helps them to develop adaptive representations to respond to novelty (Walsh, 1995; Tripsas & Gavetti, 2000). To this end, middle and operational managers behave as the agents of innovation, who alert the organization to opportunities and threats (Eggers & Kaplan, 2013; Helfat & Peteraf, 2015). Yet, our understanding of how novel technological opportunities are best communicated in order to garner the attention and support of top managers at incumbent firms remains limited.

Gavetti, Levinthal and Rivkin (2005) suggest that communicating and framing innovation and change in terms of analogies and metaphors is a powerful mechanism that allows managers to effectively search and create new representations of novel domains. Transferring knowledge and insights from familiar domains to new ones allows managers to form new representations and insights that can guide their decisions and actions (Cornelissen & Clarke, 2010; Gary et al., 2012; Vechiatto, 2020). Whilst this might allow new representations to emerge, it will not necessarily facilitate the pursuit of novelty at incumbent firms. The inherent uncertainty associated with such ideas looms large for managers and decision-makers in incumbent organizations, because whether they will be a success or failure is unknowable without implementation and experimentation (Rindova & Petkova, 2007; Boudreau et al., 2016). As a consequence, novel technological opportunities are routinely rejected. Historically, there are numerous examples of managers unwisely ignoring or rejecting novel technological ideas, such as Polaroid's rejection of digital photography (Tripsas & Gavetti, 2000) and Blockbuster's rejection of online streaming services (Raffaelli, Glynn & Tushman, 2019).

Recently, there has been growing interest in how emotion can shape cognition and managerial responses to innovation and technological change (e.g. Huy & Zott, 2019; Brusoni, Laureiro-Martinez, Canessa & Zollo, 2020; Vuori & Huy, 2016; In-Press). Given that the pursuit of novel technological opportunities and its outcomes can have consequences for individuals and groups within the organization, emotional responses are likely to be elicited from organizational actors, depending on how their goals and wellbeing are impacted (Lazarus, 1991a; Menges & Kilduff, 2015). This is significant, given research has found a recursive relationship between cognition and emotion, with emotions affecting how organizational actors think and behave (Pessoa, 2008; Gavetti, 2012), which can have implications for the organization. For example, Vuori and Huy's (2016) study of Nokia demonstrated how middle managers' experience of fear towards senior managers led to a breakdown in communication and failure of the innovation process. Fear subsequently prevented Nokia from producing a smartphone that could effectively compete with Apple or Samsung, resulting in the organization surrendering their market leadership (Lamberg, Lubinaitė, Ojala & Tikkanen, 2019). Similarly, research has shown how managers' emotional attachment to the status-quo can inhibit their ability to pursue novel technological opportunities (Gavetti, 2005; Brusoni et al., 2020). This issue afflicted top managers at Smith Corona (Danneels, 2011) who found themselves cognitively tied to the company's past as a type-writer company, which prevented them from making the move into alternatives domains, ultimately leading to their demise.

While there is evidence that emotion may impede technological opportunities from being explored and innovation from taking place, there is also evidence that suggests emotion can help facilitate these processes. Conceptual work attributes Netflix's success in adopting online streaming services to the top management's framing of the opportunity as consistent with the company's values and aspirations, thus triggering a positive emotional response capable of overcoming inertial forces

(Raffaelli, Glynn & Tushman, 2019). Indeed, the efficacy of such positive framing and communication has been empirically claimed by others (Van den Steen, 2005; Ravasi & Schultz, 2006; Rindova, Dalpiaz & Ravasi, 2011). However, the marginalization and ignorance of emotion in prior innovation and behavioural scholarship (Hodgkinson & Healey, 2011) means that our understanding of how emotion is experienced in, or how it might affect, innovation and the pursuit of novel technologies remains limited (Garud, Tuertscher & Van de Ven, 2013). This omission is all the more surprising given that Herbert Simon – who's work arguably inspired the interest in managerial cognition – acknowledged the role that emotion plays in the decision-making process. Simon noted that "motive and emotion are major influences on the course of cognitive behaviour, [and so] a general theory of thinking and problem solving must incorporate such influences" (1967, p.29). Despite such early signals regarding the importance of emotion in processes of organizational decision-making, emotion has largely taken a backseat in scholarly inquiry, leading to numerous calls for research which explicitly explores the role that emotion plays in decision-making through the lenses of organizational innovation and strategy (Cohen, 2007; Hodgkinson & Healey, 2011; Gavetti et al., 2012; Vuori & Huy, 2016; In-Press; Healey & Hodgkinson, 2017).

Although a number of emotions may be experienced in the pursuit of novel technological opportunities, extant research suggests that fear is likely to be prevalent and salient (Baumgartner, Pieters & Bagozzi, 2008; Brusoni et al., 2020). This is because fear is elicited by appraisals of threat or danger (potential or actual) in the environment, coupled with appraisals of low or uncertain ability to cope with, address or escape such threats (Frijda, 1988; Lazarus, 1991c), which seem likely given the pursuit of novel technologies is inherently uncertain (Garud, Van de Ven & Tuertscher, 2013). In this study, fear is understood as a discrete, negatively valenced emotion concerned with appraisals of threat or danger and low or uncertain coping potential, in keeping with conventional appraisal definitions of fear (Smith & Ellsworth, 1985; 1987; Ellsworth & Smith, 1988; Frijda, 1988; Lazarus, 1991c; Ellsworth & Scherer, 2003). Although some commentators have differentiated between fear and anxiety (e.g. Lazarus, 1991c; Brusoni et al., 2020), this study does not differentiate between the two. Instead, it follows scholars who treat fear and anxiety synonymously on the basis that they have a common shared meaning (i.e. appraisals of threat or danger; high levels of uncertainty; limited capacity to address or act on threat) and that the main difference between the experience is the imminency of the threat (e.g. Smith & Lazarus[1], 1990; Cacciotti & Hayton, 2015).

While fear, as with any emotion, is generally an individual-level phenomena, it can become 'shared' and experienced at the group-level. Members of the same group are likely to experience and

[1] To avoid confusion given Lazarus appearing in citations for both differentiating and not differentiating between fear and anxiety: in their 1990 publication, a footnote explicitly addressed how Craig Smith saw no need to differentiate between fear and anxiety and therefore did not do so. Conversely, Richard Lazarus saw it as an important distinction.

appraise environmental stimuli in a similar manner, considering what they mean for the group's goals and wellbeing, which can lead them to share the same emotional experience (Menges & Kilduff, 2015). Additionally, group members may come to share their emotions on the basis of their interactions with one another, in a process known as emotional contagion (Barsade, 2002). In both instances, the behavioural consequences and effects of fear (and other emotions) can be amplified when shared amongst groups, which can have implications for how the organization may be able to pursue novelty and innovation. Further complicating matters is that inter-group differences may emerge in terms of when emotions like fear are experienced: different groups exist in the organization with their own roles and goals (Cyert & March, 1963; Ocasio, 1997), leading to distinct appraisal patterns being made. Generally, because fear is said to motivate withdrawal (Smith & Ellsworth, 1987), it has been theorized to impede the exploration and pursuit of technological opportunities because it can cause the groups involved to avoid or withdraw from these situations (Vuori & Huy, 2016; Zuzul, 2019; Brusoni et al., 2020). However, recent work has suggested that perceptions of threat and limited coping potential – which are antecedents to the experience of fear – may in fact lead to incumbents engaging with and pursuing novel technological opportunities (König, Graf-Vlachy & Schöberl, 2021). This discrepancy reinforces how emotions typically trigger action *tendencies* opposed to fixed actions (Elfenbein, 2007) and that the actions motivated will be contingent on what individuals deem appropriate for the situation at hand. Moreover, it suggests that our current understanding of fear in the pursuit of novelty and innovation might be underspecified, warranting further investigation and exploration.

In light of our limited understanding regarding how managers ought to communicate novel technological opportunities and the role that emotion can play in the pursuit of novel technologies – along with these calls for research on the matter – this thesis seeks to answer two primary research questions:

(1) *How do managers communicate novel technological opportunities in incumbent organizations, in order to gain the attention and support of key organizational decision-makers?*

(2) *How does emotion affect the pursuit of novel technological opportunities in incumbent organizations?*

To address these research questions, I examined the case of quantum key distribution (QKD) technology at TechCorp (pseudonym), a longstanding multi-technology incumbent, following the attempted commercialization of this innovation. The highly novel and early-stage nature of QKD made it a theoretically relevant case to study (Eisenhardt & Graebner, 2007; Siggelkow, 2007) since its novelty made its likely commercial success unknown and unknowable (Rindova & Petkova, 2007). Furthermore, because QKD was highly novel, it constituted a significant departure from the organization's existing way of providing encryption. Subsequently, the success or failure of the project had significant implications for groups across the organizations, meaning that a variety of emotions

were likely to be experienced (Cyert & March, 1963; Huy, 2012; Menges & Kilduff, 2015). Through a 24-month qualitative case study of QKD at TechCorp, I focused on two key groups involved in these commercialization attempts: the Research and Development (R&D) department, and the Customer-Serving Units (CSUs), who were responsible for exploration and exploitation (March, 1991) at the organization respectively. By following and examining the thoughts, feelings and (inter)actions of these two groups, I was able to develop an empirically grounded process model showing how emotion can affect the pursuit of novel technological opportunities in incumbent organizations. This model highlights both the emotional dynamics that can characterise the process of pursuing novel technologies in incumbent organizations, as well as elucidating how novel technologies are communicated in these settings, which allows this study to address what communicative strategies are more and less effective over time.

The findings of this study offer three main contributions to the literatures on the incumbent pursuit of novel technology and emotion. First, this thesis revisits the role of fear in the pursuit of novel technology. While prior literature suggests that fear impedes exploration and innovation (Vuori & Huy, 2016; Brusoni et al., 2020), this study offers an alternative but complementary commentary by showing how fear – a negative emotion – may be able to propel this process forwards. As an emotion concerned with protecting from threat or harm, fear has strong motivational capabilities that can induce managers to take actions to avoid a feared threat (Kish-Gephart et al., 2009; Damasio & Carvalho, 2013). In circumstances where a novel technology is interpreted as a viable way in which to escape or avoid a feared threat, fear may motivate engagement with such technologies. The findings of this study show how fear may facilitate the pursuit of technological opportunities by motivating managers to build positive sentiment around them, which was achieved by communicating novel technology in terms of the internal organizational and external governmental aspirations it could help fulfil. Accordingly, this study suggests under what conditions – and how – fear may facilitate the pursuit of novel technological opportunities, thus positioning fear as a potential enabler of the pursuit of novel technologies in incumbent organizations. Additionally, this study identifies how discrete forms of fear may be experienced in the pursuit of novel technologies, uncovering how *fear of failure* and *fear of missing out* exist. As such, this study responds to calls from scholars (Gavetti, Levinthal & Ocasio, 2007; Hodgkinson & Healey, 2011) to integrate insights from psychology to advance our understanding of emotion in the pursuit of novelty and innovation, offering a platform from which organizations may be able to harness the productive potential of fear. Moreover, it brings into question the trend to normalize failure, which although well-intentioned, may be misplaced (Danneels & Vestal, 2020), because it prevents organizations from enjoying the benefits associated with fear of failure.

Second, I build on recent theorizing around the importance of managerial communication as a means to build strategy and advance innovation (Helfat & Peteraf, 2015; Ocasio, Laamanen & Vaara, 2018), unpacking specific communicative strategies at their disposal. Specifically, this study shows

how middle and operational managers might articulate novel technological opportunities in terms of aspirations as a means of establishing their value and legitimacy. More pertinently, the findings of this study also suggest that middle and operational managers might communicate novel technological opportunities to evoke negative emotions in key decision-makers, rather than positive emotions as previous research would suggest (cf. Raffaelli, Glynn & Tushman, 2019). Communications using positive emotions may be dismissed as emotional and irrational, whereas the same messages packaged in terms of negative emotions may capture the attention of key decision-makers and garner support because they convey potential detriments to goals and wellbeing. In keeping with principles of loss aversion (Tversky & Kahneman, 1991), this may encourage risk-taking (i.e. pursuing novel technologies) that can remedy these potential threats.

Third, this study highlights how managers involved in the pursuit of novel technologies may experience mixed emotions about such opportunities, which may cause periods of indecision when the actions these emotions motivate are contradictory and are difficult to resolve. In this manner, this study examines *univalent emotional ambivalence*, an under-studied form of ambivalence in the literature (Rothman et al., 2017), and advances a positive perspective on ambivalence (Fong, 2006; Rothman & Melwani, 2017) by suggesting that indecision can – paradoxically – benefit the emergence of novel technologies in incumbent organizations by affording them time and space in which to develop. The idea that indecision can be productive differs from prior research on the topic which has portrayed it as problematic (cf. Charan, 2001; Denis, Dompierre, Langely & Rouleau, 2011), while linking emotional ambivalence to indecision allows this study to build on prior accounts (Simon, 1947; Charan, 2001) to suggest how emotional factors can contribute to indecision.

This dissertation is comprised of six chapters in total, and is organised as follows. In *Chapter 2*, the literatures on innovation, the challenge of incumbency and the psychology of emotion – which form the theoretical background of this study – are reviewed and problematized to highlight the need for this work. In *Chapter 3*, I provide an overview of the methodological design of the study, explaining the ontological and epistemological assumptions on which this thesis is based, the empirical setting, data collection and analysis techniques utilized, as well as ethical considerations and the data management techniques drawn upon. In *Chapter 4* I present the findings of this study, which I introduce and address in three main stages. In *Chapter 5* I present the process model derived from my findings, discuss what my findings mean in terms of extant theory and literature, and consider their managerial implications. The final chapter of this thesis, *Chapter 6*, reflects on the key theoretical contributions of this study, as well as its limitations and the avenues it identifies for future research.

2 Literature Review

This chapter provides an overview of the literature that is drawn upon in this thesis (summarized in Figure 2.1), identifying key trends as well as areas where our understanding is currently limited. Section 2.1 explores the roots of innovation, beginning with an overview of what is meant by innovation, how it has been studied and why the pursuit of forms of novelty is important for organizations. In Section 2.2, I consider the literature which has examined and sought to explain the challenges of innovating in large, established organizations. Having reviewed the predominant cognitive and structural explanations of incumbent inertia and identified a limited body of work that considers the role of emotion in the incumbent innovation process[2] (Section 2.2.3 and 2.2.4), Section 2.3 is devoted to examining the literature from psychology on emotion, providing an overview of what

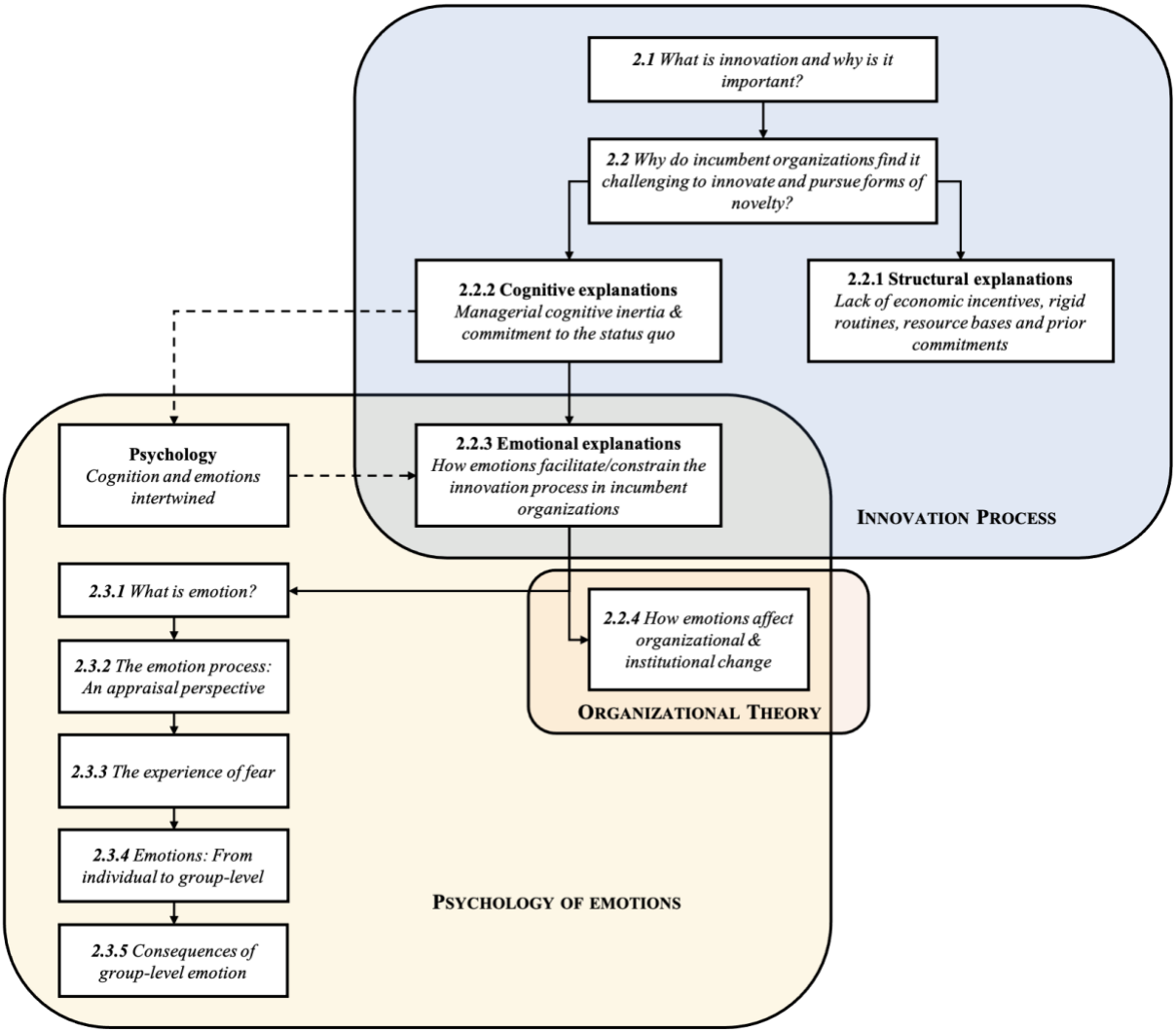


Figure 2.1 - Overview of reviewed literature

[2] Please note that given the abductive nature of this study, the reality of this literature review was that it occurred in two stages. While the broader innovation literature was reviewed at the outset, the literature on emotion in innovation and psychology was addressed while I was in the field, when my focus became more explicitly on emotion (see Chapter 3, Section 6.2 for more detailed discussion on the stages of analysis).

emotions are, how they have been conceptualized, an examination of the experience of fear, as well as and how emotion might come to be experienced at the individual and group-levels. The chapter finishes with a summary of my literature review and research questions that stem from it, as well as identification of relevant calls for research that this thesis addresses.

2.1 Innovation: the 'lifeblood' of organizations

Interest in innovation has burgeoned in the last half century, the term becoming ubiquitous in both academic literature and everyday management parlance. Looking at measures of the most profitable and valuable organizations in the world, outside of oil and banking the most highly valued organizations are the likes of Apple, Alphabet[3], Amazon and Microsoft (Financial Times, 2019; Forbes, 2020), organizations who are synonymous with the term innovation. The ability of organizations to come up with and produce new, superior products and services to outcompete others is a major determinant of success (Schumpeter, 1934; 1950), and so it is unsurprising that empirical studies have found positive associations between company innovativeness and firm performance (Crossan & Apaydin, 2010), leading to many scholars arguing that innovation is the ultimate endeavour for organizations (Schumpeter, 1942; Tushman & Anderson, 1986; Tushman & Nadler, 1986). In this respect, it is assumed that being an effective innovator leads to success whereas an inability to innovate will lead to a firm's demise and/or failure (e.g. Danneels, 2011; Raffaelli, Glynn & Tushman, 2019).

2.1.1 What is innovation?

The roots of innovation can be traced back to the early 20th Century, when Joseph Schumpeter (1934; 1942; 1950) described a never-ending cycle characterised by new entrants[4] producing technologically superior products that displace incumbents, which he termed the waves of creative destruction. According to Schumpeter, innovation entailed iterative cycles where "new combinations" (1934, p.66) of resources, materials, and/or means of production led to the genesis of new and superior products at the expense of existing products, and the replacement of incumbents by new entrants. Schumpeter's ideas laid the foundations for subsequent research on and definitions of innovation, which have echoed the notions of novelty and the iterative nature of innovation that were evident in his work. For example, Rogers defined innovation as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (1962, p.12), while Damanpour referred to "the generation, development, and adaptation of novel ideas on the part of the firm" (1991, p.556). More recently, scholarship has begun to emphasise the different stages involved in innovation, describing innovation as the invention, development, and implementation of new ideas in the real world (Garud, Tuertscher

[3] Alphabet are the parent company of Google.
[4] In his later work, Schumpeter (1950) did acknowledge that established firms held certain advantages over new entrants, but maintained that new entrants were generally the source of breakthrough innovations.

& Van de Ven, 2013). In this respect, innovation is characterised by three key features: novelty, an iterative nature, and attempts to implement in the real world. This latter point has become more prominent in recent times, as scholars have sought to distinguish between invention and innovation. Invention is related to innovation[5], but refers specifically to the first occurrence of an idea, which typically is the beginning of the innovation process. On the other hand, innovations represent attempts to put ideas into practice in the real-world and generally entails economic benefit of some sort (Schumpeter, 1934; Freeman & Soete, 1997). Given this thesis seeks to explore how innovation occurs within large, established organizations (i.e. the innovation process), innovation is simply defined as "the invention, development, and implementation of new ideas" (Garud, Tuertscher & Van de Ven, 2013, p.774).

A factor which can muddy the water with innovation scholarship is that many different forms and types of innovation have been identified in prior scholarship. This has led to scholars using a multitude of different labels to define innovation based on the characteristics of the innovation itself, or alternatively environmental and organizational factors (Mount, 2012). For example, there have been efforts to distinguish between innovation which occurs internally and within the confines of the organization (closed innovation) and innovation that occurs across a network of actors (open innovation [Chesbrough, 2003]). A systematic review of the innovation literature carried out by Crossan and Apaydin (2010) found that researchers have classified innovations on structural features, distinguishing between product, process and technical forms of innovation. Product innovation refers to "a new technology or combination of new technologies introduced commercially to meet a user or a market need" (Utterback & Abernathy, 1975, p.642), whilst process innovations are a means for the organization doing something better through changes to its technological and production processes. Generally, product innovation precedes process innovation, as organizations decide whether or not to innovate or imitate others. However, once a dominant design emerges, the focus switches to process innovation and seeking operational efficiencies. Henderson and Clark (1990) distinguished between two types of technical innovation, architectural and modular. Architectural innovations involve the reconfiguration of an existing system, so the components link in a new way, whereas modular innovations involve a change in the core design of a subsystem but without changing the linkages between parts.

Other scholars have differentiated between innovations based on their characteristics rather than aforementioned structural factors. For example, the extent of change or degree of novelty in terms of the knowledge, routines and resource bases involved in delivering an innovation distinguishes between incremental and radical forms of innovation (Benner, 2007; Ansari & Krop, 2012). Similarly, with

[5] In fact, more recent conceptualizations of innovation generally encompass invention as the first stage of the innovation process (for a detailed discussion please see Garud, Tuertscher & Van de Ven, 2013).

respect to technological innovations, whether the technology uses new technology or simply builds on existing technology, and whether or not it extends an existing or creates a new trajectory, differentiates continuous and discontinuous technological innovations (Damanpour, 1991). At the level of the organization, whether or not it builds on existing resources and capabilities or not distinguishes competence-enhancing from competence-destroying innovations (Tushman & Anderson, 1986) innovations. Finally, at the market level, the notion of sustaining versus disruptive innovation has been used to establish how an innovation affects demand dynamics for an organization (Christensen & Bower, 1996). Disruptive innovations transform industry structures towards new value dimensions, whereas sustaining innovations improve performance along dimensions that customers currently value (Christensen, 1997).

In this thesis, I focus on how organizations pursue novel forms of technological innovation. Innovations can be characterised on the degree of novelty they involve with respect to the knowledge, routines and resources organizations require to deliver them. As mentioned previously, when innovations build on fundamentally new knowledge, involve new routines or require new resources (i.e. are characterised by high levels of novelty) they are defined as radical forms of innovation (Benner, 2007; Ansari & Krop, 2012). Radical forms of innovation often correspond to, or are used interchangeably with, the concepts of discontinuous (Damanpour, 1991) and competence-destroying (Tushman & Anderson, 1986) innovation. This reflects how radical innovations may undermine, replace and/or destroy extant competencies, and as a result of their novelty means that they are on new – often unknown – technological trajectories. Throughout this thesis, I use the term 'novel' and 'radical' interchangeably, which is motivated by the fact that many of my informants referred to innovation as 'novel' and on scales of 'newness' rather than radical or radicalness.

2.1.2 Why is innovation and pursuing forms of novelty important?

The pursuit of novelty – that is, the pursuit of radical forms of innovation that are characterised by high levels of novelty – is important for a number of reasons. March (1991) succinctly captured many of these in his article on exploration and exploitation, surmising that successful organizations engage in a balance of both exploitation and exploration[6] in order to pursue both operational efficiency alongside the discovery and development of new ways of doing things. Doing so, March argued, was essential to survive and compete in both the short- *and* long-term. Building on these ideas, scholars now accept and purvey that in order to survive and thrive, organizations must balance the development and pursuit of incremental forms of innovation with more radical forms of innovation (Levinthal & March, 1993; Smith & Tushman, 2005; Denrell & Le Mens, 2020). Organizations require a source of revenue in order to fund their ongoing activities, something that incremental innovations are able to immediately

[6] The concepts of exploratory and exploitation as proposed by March (1991) are associated with radical and incremental forms of innovation respectively.

and reliably provide since they build on extant knowledge and resources (Greve, 2007). However, organizations must also contend with constant environmental change, which has become the norm in the last half century (Kumaraswamy, Garud & Ansari, 2018). What this means is, if firms are to compete effectively, they must be able to change and adapt processes which are underscored by innovation (Cyert & March, 1963; Levinthal, 1991; Garud & Kumaraswamy, 1995; Brown & Eisenhardt, 1995). In particular, radical forms of innovation which are based on new knowledge, routines and resources (Benner, 2007) not only allow organizations to respond to environmental changes, but may also be an avenue through which they can discover new opportunities that allow them to outcompete their competitors (Eggers & Park, 2018). The pursuit of novel technologies and solutions is therefore a critical endeavour for contemporary organizations, to both survive and prosper.

The importance of innovation and the pursuit of novelty has been reflected by a growth in scholarship which has sought to understand how innovation takes place; that is, the tendency to study the innovation process itself (Garud, Tuertscher & Van de Ven, 2013). While this body of literature has acknowledged the importance and value of pursuing forms of novelty, it has also stressed the challenges of this endeavour for organizations. More novel, radical forms of technology depart from – rather than build upon – existing knowledge and resource bases (Gatignon, Tushman, Smith, & Anderson, 2002; Benner, 2007) and reside in distant, unfamiliar domains (Gavetti & Levinthal, 2000; Gavetti, 2005). As a consequence, the pursuit of novel technologies or solutions can devalue and undermine existing resources and capabilities, and often entails their cannibalization (Chandy & Tellis, 2000; Benner, 2007). For example, Apple's decision to introduce the iPhone, which combined mobile phone technology with multimedia technology, involved the devaluing and cannibalization of the Apple iPod and its associated technology (van Heerde, Srinivasan & Dekimpe, 2010; Ritchie, 2019). Moreover, novel technologies not only depart from extant knowledge and resource bases, but also known customer demand. In this manner, the success of novel technologies is uncertain and unknowable *ex ante* (Rindova & Petkova, 2007; Boudreau et al., 2016), because without experimentation it is unclear whether or not they will prove to be successful with consumers. Nevertheless, the possibility that novel technologies and solutions may transform landscapes and markets makes them attractive to organizations (Tushman & Anderson, 1986; Hill & Rothaermel, 2003). While the introduction of the iPhone may have required to cannibalization of the iPod, it propelled Apple to the forefront of the smartphone market, where it continues to hold a prominent position (Ritchie, 2019). Similarly, the adoption of platform streaming technology by Netflix cannibalized their existing routines and competencies around postal distribution, in order to provide customers with an enhanced experience, facilitating their ascension to becoming the leader in the market for TV and movie streaming (Pogue, 2007; Ansari & Krop, 2012). In this manner, organizations pursue novelty on the basis that they are high-risk, high-reward strategies that can thrust them to the heights of their respective industries or markets. However, to guard against such risk, it is advisable to establish a balanced portfolio of high-

risk, novel innovations alongside incremental innovations that are lower-risk, lower-reward, to ensure the ongoing survival and competitive of the organization (Levinthal & March, 1993; Greve, 2007).

The pursuit of novelty is undoubtedly a challenge for organizations, with commentators arguing that the issue is particularly acute for incumbents (Hodgkinson & Healey, 2011; 2014), who often struggle to innovate and pursue novelty. This is intriguing, because incumbents are well-endowed with knowledge and resources (Eggers & Park, 2018) which presumably makes them capable of identifying and capitalizing on the opportunities presented by novel technologies and solutions. However, there is a vast literature identifying various challenges that large, establish organizations must navigate in order to successfully pursue novel technological opportunities. Over the last three decades, the challenge of incumbency with respect to novel innovations has been repeatedly examined (e.g. Henderson & Clark, 1990; Tripsas, 1997; Tripsas & Gavetti, 2000; Hill & Rothaermel, 2003; Gilbert, 2005; Benner, 2009; Eggers & Kaplan, 2009; Danneels, 2011; Benner & Tripsas, 2012; Vuori & Huy, 2016; Raffaelli, Glynn & Tushman, 2019), and yet this issue still perseveres, which suggests that there are additional layers to the problem which remain to be explicated. Specifically, how organizations ought to be structured and managed such that they *are* able to pursue novel technologies and solutions (Simon, 1947). Understanding how incumbents can successfully innovate and pursue forms of novelty is not solely an academic endeavour, but also has implications and potentially profound benefits for society. For example, incumbent organizations assume a major role in many global grand challenges, such as the fight against climate change, where the ability to innovate in a way that is completely different to what we currently know and do may be critical to avoid irreversible damage occurring to the planet, or to feed the globe's growing population. Accordingly, this thesis sets out to examine the challenge of incumbency and explain how large, established organizations are able to successfully pursue game-changing and breakthrough forms of technological innovation.

2.2 The challenges of innovating in incumbent organizations

While large, established organizations are in a favourable position with regards to innovating and delivering novel technologies and ideas to the marketplace, research has shown that they often struggle with this task (Eggers & Park, 2018). There are numerous examples of incumbent organizations who have been the source of novel technological breakthroughs but failed to capitalize on these opportunities within the innovation literature, including Polaroid and Kodak with digital photography (Tripsas & Gavetti, 2000; Gavetti, Henderson & Giorgi, 2005), Blockbuster with online streaming platforms (Raffaelli, Glynn & Tushman, 2019) and Nokia with smartphone technology (Vuori & Huy, 2016; In-Press). Given there are clear real-world implications for whether incumbents can deliver novelty to the marketplace, the challenge of incumbency has received much scholarly attention, and will continue to do so. Indeed, incumbent innovation has been particularly critical with respect to the

ongoing COVID-19 pandemic, where large pharmaceutical incumbents have been challenged to identify and deliver a vaccine in record time. To date, scholars have generally approached the (in)ability of incumbents to innovate from either structural or cognitive perspectives.

2.2.1 Structural factors

From a structural perspective, incumbents are constrained in their ability to innovate and pursue novelty because of their existing resources, capabilities and routines, or structural characteristics of the markets or environments in which they operate. Incumbent organizations often struggle to alter their prior resource commitments and innovate in a way that is inconsistent with them, which can be attributed to the lack of economic incentives to do so (Henderson & Clark, 1990; Henderson, 1993). Introducing novel technologies and solutions to the marketplace can create disequilibrium that reduces the market power of incumbents, creating circumstances that allow start-ups to enter and compete in the market (Gilbert and Newbery, 1984; Reinganum, 1984). New entrants generally struggle to compete in established domains with incumbent organizations, given the accumulated knowledge and experience of incumbents. However, new product and service domains where the playing field is more level represents a context in which incumbents could be outcompeted by more responsive and agile start-ups. Incumbents are therefore economically disincentivised to innovate and pursue forms of novelty in this respect.

Similarly, the pursuit of novel technologies and solutions can reduce the value of extant resources and capabilities that incumbents possess, which in the worst-case scenario may result in them being rendered obsolete (Sull, Tedlow & Rosenbloom, 1997; Benner & Tushman, 2002; Benner & Waldfogel, 2016). Such scenarios are not advantageous for established organizations who must then reinvigorate their resource bases, which has costs in terms of time and money. This translates into a general unwillingness to cannibalize extant resources (Bugelman, 1994; Chandy & Tellis, 2000) and can cause incumbents to suffer from "routine rigidity" (Gilbert, 2005, p.742), where their commitment to the status quo (Christensen, 1997) hampers their ability to innovate. When incumbents have a stock of specialized complementary assets, this issue may be particularly prevalent because such assets are only valuable in the context of a specific innovation (Teece, 1986; Benner, 1997). Accordingly, incumbents may be disinclined to venture far from this domain. Over time, resource commitments can also develop into path dependencies, where past decisions and actions influence the likelihood of future courses of action and outcomes (Teece et al., 1997; Sydow et al., 2009). This occurs by limiting the range of alternatives which are available to the organization, or by impacting the costs and benefits associated with various alternatives (Greve & Seidel, 2015), making some more accessible or permissible than others. In extreme cases, these decisions can lock firms into – or out of – certain technological trajectories (Dosi, 1988; Schilling, 1998; Danneels, 2002; Vergne & Durand, 2010), which can be consequential for how they can innovate and perform subsequently. For example, organizations in the television industry had to commit to forms of digital technology prior to the

transition from analogue to digital televisions, and before the dominant standard had been established (Gnyawali & Park, 2011; Benner & Tripsas, 2012). In committing resources to a specific technological trajectory, they were subsequently constrained in their ability to pursue alternatives.

Scholars have also highlighted that organizational routines may limit the ability of incumbents to innovate and pursue novelty. Routines are "repetitive, recognizable pattern of interdependent actions, involving multiple actors" (Feldman & Pentland, 2003, p.96) which allows firms to respond to problems or environmental stimuli with a fixed, organized response and thus perform tasks in a repeatable and reliable manner (March & Simon, 1958; Cyert & March, 1963; Nelson & Winter, 1982). Routines help to overcome the cognitive limitations of organizational actors and mitigate uncertainty (Gavetti et al., 2012), behaving as a source of stability. This is advantageous in stable environments (Hannan & Freeman, 1989; Feldman & Pentland, 2003; Benner, 2009), however when there are high levels of exogenous change, routines may become a "cumbersome structural constraint" (Zuzul & Tripsas, 2020, p.3) that limit the ability of incumbents to respond. In this respect, routines are a potential source of organizational myopia (Levinthal & March, 1993), because they can direct attention to known domains, leading to ideas and solutions being discovered near to existing ones, thereby maintaining the status quo (Cyert & March, 1963). As routines are complex processes and typically involve a number of tacit and unknown elements, this means that attempts to alter them can have unintended and unanticipated consequences (Rumelt, 1995). Subsequently, organizations can be discouraged from innovating and pursuing change for concerns about detrimental consequences (Hill & Rothaermel, 2003; Davis, Eisenhardt & Bingham, 2009). When routines previously allowed organizations to successfully outcompete their competitors, they are likely to be particularly enduring (Helfat & Winter, 2011), and even in the face of negative performance feedback, research has shown that routines have a tendency to persist (Gilbert, 2005). As such, what was once a source of competitive advantage and success for an incumbent organization can quickly become a detriment that prevents them from effectively competing (Leonard-Barton, 1992).

There is also evidence that the distribution of power, as well as political behaviour, within incumbent organizations can play a role in whether or not they are able to innovate and pursue forms of novelty or not. Behavioural scholarship in particular has conceptualized the organization as consisting of political coalitions, in which members and groups each have their own distinctive goals and interests (Cyert & March, 1963; Ocasio, 1997) and will take action to protect and further these. What decisions the organization will make are largely determined by the interpretations and attention of the most powerful individuals and groups within the organization (Ocasio & Joseph, 2005; Joseph & Wilson, 2018). In this respect, Zhang and Greve stated that whilst "problemistic search predicts when organizations change, [the] dominant coalitions predict which alternative is chosen." (2019, p.44). Research has shown how the distribution of power can impact what activities incumbents engage in

(Mintzberg, 1984), sway how responsive they are to competitors (Eggers & Kaplan, 2009), and can influence whether or not they choose to adopt new technologies (Kaplan, 2008).

Generally, innovation scholarship has adopted a sociological perspective of power, and thus power is seen to derive from formal authority and control over vital resources (Pfeffer, 1981; Fleming & Spicer, 2014). As authority and control over vital resources are susceptible to change, this means that power can flow throughout the organization. Consequently, actors and groups stand to both gain and lose power. Because innovation and forms of novelty introduce change to the organization, they may cause the redistribution of power relations, resulting in actors and groups behaving politically to either preserve or extend their relative power. In some circumstances, this can potentially derail incumbents from delivering novel technologies and solutions to the marketplace. Relatedly, specific individuals or groups may accrue power if they are able to manage sources of uncertainty (Crozier, 1964), provide a non-substitutable input (Pfeffer & Salancik, 1974) or are positioned centrally in the organization's workforce (Hickson et al., 1971; Hinings et al., 1974). In such circumstances, these groups enjoy power and influence, but are unlikely to support innovative endeavours given these could undermine their positions. Instead, they will generally maintain the status quo in order to preserve their own position within the organization, limiting the ability of incumbent firms to innovate and pursue novelty.

A particularly powerful set of stakeholders in the innovation process are consumers, by virtue of being the source of vital financial resource (Pfeffer & Salancik, 1974). Without financial resources, incumbents will struggle to maintain their operations and exist, and thus this resource dependency can cause incumbents to shun novel technologies and solutions on the basis that they are not valued by existing customers and would result in a loss of a key resource if pursued (Christensen & Bower, 1996). In this manner, customer preferences limit how incumbents are able to alter the allocation of their resources (Bower, 1970). The pursuit of particularly novel forms of innovation often necessitates that organizations cannibalize their existing products and revenue, but incumbents often exhibit "resource rigidity" (Gilbert, 2005, p.742) – a failure to change resource investment patterns – which prevents them from doing so, which can lead to their downfall (Christensen & Rosenbloom, 1995; Christensen & Bower, 1996; Christensen, 1997). Incumbents must also contend with other organizations situated in their wider ecosystem and network. Contemporary organizations are highly interdependent, and thus their extant commitments to other organizations may limit their latitude to act and innovate, particularly if it is unfavourable for their collaborators to whom they have contracts or long-standing commitments (Hill & Rothaermel, 2003; Järvi & Kortelainen, 2017; Shipilov & Gawer, 2020).

2.2.2 Cognitive factors

There has also been a fruitful line of work exploring how the cognitive structures and processes of organizational members can affect the ability of incumbents to innovate and pursue forms of novelty. The conceptual roots of the managerial cognition tradition can be traced back to the work of the Carnegie School, specifically that of Herbert Simon (1947; 1955), James March and Richard Cyert

(March & Simon, 1958; Cyert & March, 1963). This set of scholars developed the behavioural perspective as a response to the theory of the firm proposed by classical economists[7], who assumed that organizational actors enjoyed perfect information and who made decisions on the basis of utility maximization, facing no issues in internal resource allocation (Gavetti et al., 2012). Cognition sits at the heart of the behavioural perspective and thus by integrating insights from psychology, behavioural scholarship identified and emphasised the bounded rationality of organizational actors (Simon, 1947; 1955), which has become a cornerstone of subsequent cognitive approaches. Whilst organizational actors may intend to make rational decisions, their ability to do so is constrained by imperfect information, their own cognitive limitations in gathering, interpreting, and processing new knowledge, as well as an unawareness to what extent their understanding of the world is accurate or not (Simon, 1955; Ocasio, Rhee & Boynton, 2020). In being "cognitively constrained" (Cohen, Bingham & Hallen, 2019, p.812), actors are intendedly rather than truly rational, since they do not have the capacity to accurately and comprehensively process all information in order to make decisions (Simon, 1978). On this basis, a cognitive perspective (for reviews see Walsh, 1995; Eggers & Kaplan, 2013) posits that what decisions managers make, and actions that organizations subsequently take, depends on how managers interpret their environment (Daft & Weick, 1984; Prahalad & Bettis, 1986; Porac, Thomas & Baden-Fuller, 1989; Barr, Stimpert & Huff, 1992; Ocasio, 1997; Gavetti, 2005; Benner & Tushman, 2012).

One way in which managers manage their cognitive limitations is to rely on cognitive frames[8] as a way of screening, filtering and simplifying environments (March & Simon, 1958). Instead of attending to the environment in its entirety, frames[9] foreground certain elements of the environment

[7] The accounts put forwards by economists showed little concern for the organizational decision-making process (Cyert & March, 1963) despite decision-making being at "the heart of administration" (Simon, 1947, p.xlvi). Accordingly, Simon, March and Cyert set out to offer an alternative theory of the firm which adhered to three principles: the organization being the object of study, decision-making being the focus of investigation, and any subsequent theory developed being behaviourally plausible, which they sought to achieve by integrating insights from psychology (Gavetti, Levinthal & Ocasio, 2007). The behavioural perspective therefore sought to explain how organizations and individuals act and make decisions in the real world, accommodating rational aspects of choice with the cognitive limitations of decision makers, therefore using both economics and psychology to help understand and explain organizational decision-making and provide a theory of organization that reflects its behavioural realities.

[8] Cognitive frames are closely related to a number of other cognitive concepts like schemas, knowledge structures, dominant logics, interpretive schemes/schemas. Although there are some nuances in definition, conceptually they are the same, and the differing use of terminology can largely be attributed to scholarly background (e.g. sociology, psychology). These concepts all refer to the cognitive structures that actors draw upon to understand the world around them, with many having conceptual underpinnings that date back to Goffman's "schema of interpretation" (1974, p.21).

[9] A particularly prominent form of cognitive frame that managers often draw upon is organizational identity (Ravasi, Tripsas & Langley, 2020). In specifying the central, enduring and distinctive characteristics or attributes of an organization (Ravasi, Rindova & Stigliani, 2019), organizational identity construes "who we are" and "what we do" (Navis & Glynn, 2011). Thus, identity behaves as a cognitive frame that organizational members use to make sense of the world around them (Cornelissen, Haslam & Balmer, 2007), drawing their attention to certain domains and sources of information at the expense of others (Tripsas, 2009). Identity can therefore make certain courses of action and innovations more legitimate and palatable than others (Altman & Tripsas, 2015). In this

whilst backgrounding others, allowing managers to simplify situations and bring them within the confines of their processing capacity, which allows them to make decisions and take action (Eggers & Kaplan, 2013; Cornelissen & Werner, 2014). However, in making salient only some aspects of the environment, frames can make managers susceptible to oversight (Porac et al., 1989) and potentially biases (March, 1994; Miller & Shapira, 2004). For example, managers form expectations about the consequences of decisions and courses of action based upon experiences and interpretations of the environment as a way of helping to decide between alternatives (Gavetti et al., 2012). However, since such experiences are based upon the organization's extant frames, environmental position and activities, they can bias the firm towards local rather than distant domains, leading to a maintenance of the status quo rather than encouraging the pursuit of distant domains and novel solutions (Cyert & March, 1963; Levinthal & March, 1993). Similarly, managers have finite attentional resources, and therefore cannot attend to all aspects of the environment (Ocasio, 1997). These factors can all limit the ability of incumbent organizations to innovate and pursue forms of novelty because they determine what issues are recognized as important, or even noticed at all. For example, research has shown that whether attention is directed towards new opportunities, or towards extant products and services, can influence whether the organization choose to acquire and develop new capabilities, or whether they opt to refine existing capabilities (Garud & Rappa, 1994; Kaplan, 2008). Similar messages are conveyed by upper echelons scholars; although focused solely on top management and their extended teams (Hambrick & Mason, 1984; Cho & Hambrick, 2006), the cognitions of these actors is particularly salient because they are typically the organization's key decision-makers (Joseph & Gaba, 2020). There is evidence linking executive attention to outcomes such as organizational reorientations (Tushman & Rosenkopf, 1996), R&D investment and strategies (Kor, 2006) as well as decisions to launch or pursue products and services (Eisenhardt & Tabrizi, 1995). This underscores how the cognitions of managers – particularly those towards the top of the organizational hierarchy – play a direct role in whether or not incumbent organizations are able to innovate and pursue forms of novelty.

One challenge that managers face in trying to innovate is how to adapt or update their cognitive frames and representations[10] of the world. A plethora of scholars (e.g. Barr, Stimpert & Huff, 1992; Tripsas & Gavetti, 2000; Gilbert, 2006; Benner, 2009; Danneels, 2011) have acknowledged that managers can suffer from cognitive inertia, whereby their frames become "stuck in an old understanding of the environment" (Eggers & Kaplan, 2013, p.317). Over time, a "dominant logic" (Prahalad & Bettis,

respect, there is clear empirical evidence supporting how identity guides the strategic decisions that managers and organizations make (Dutton & Dukerich, 1991; Gioia & Thomas, 1996; Irwin, Lahneman & Parmigiani, 2018).

[10] It is important to note that cognitive frames and representations are conceptually distinct. While cognitive frames refer to the mental structures that actors draw upon to interpret and understand the world around them, cognitive representations refer to the actual mental maps of reality that actors form, and on which they act. In Zuzul's words, "while frames are like filters that colour how individuals see and interpret the world, cognitive representations are like maps that reduce and represent reality, and thus provide a basis for action" (2019, p.742).

1986, p.485) can emerge concerning the organization's environment, resources, and competitors (Reger & Huff, 1993; Kaplan & Tripsas, 2008). While these perceptual filters can be advantageous in stable environments and help to direct attention towards critical features, or established 'correct' courses of action based on experience, in a dynamic environment they may prevent managers from recognizing environmental opportunities and threats which can prevent them from being able to pursue novel technologies and solutions. For example, Tripsas and Gavetti (2000) found that at Polaroid, top managers rejected the opportunity to enter the digital photography domain because it departed from the razor/blade business model that had brought the organization its prior success, and thus was incongruent with their predominant frames and beliefs about the company. This was despite the fact that Polaroid's digital camera was of superior quality and lower price than many of its market competitors (Gavetti, 2005). Similarly, NCR struggled to make the transition to mainframe computing initially as a result of managerial cognitive inertia (Rosenbloom, 2000). Only with the arrival of a new CEO with different experiences did NCR make a successful – albeit late – entry into computing (Rosenbloom, 2000). At Intel, top managers repeatedly failed to recognize shifts in the external environment, only saved for the fact that middle managers responded autonomously[11] to help deliver microprocessor technology and allow Intel to profit from the opportunity (Burgelman, 1994).

Burgelman's (1994) study draws attention to the role and cognitive capabilities of middle managers for recognizing environment changes and opportunities. The broader strategic management literature has emphasised the critical role played by middle managers in strategy and innovation, able to communicate ideas up- and downwards and also tempering expectations in both directions as well (e.g. Burgelman, 1983a; 1983b; 1991; Floyd and Wooldridge, 1992; 1997; Dutton & Ashford, 1993; Mantere, 2008). By virtue of their proximity to and involvement in the external environment on a regular basis, middle managers are more readily able to update and form accurate cognitive representations of the environment than their counterparts above them in the organizational hierarchy (Walsh, 1995; Regnér, 2003). This means that middle managers are more adept at recognizing novel opportunities for the organization in a way that top managers are not able to. For example, Dutton and Ashford's (1993) work on issue-selling has emphasised how mid-level managers communicate perceived opportunities and threats (i.e. potential issues) upwards to their superiors. Research has shown this in practice at companies like Polaroid, where mid-level managers put forward the idea of digital photography (Tripsas & Gavetti, 2000), and Intel, where middle managers helped to drive the organization from being a memory to a processor business (Burgelman, 1983a). In this respect, middle managers are often relied upon to help update the representations of top managers (Gavetti, 2005; Taylor & Helfat, 2009), which is why a critical capability of middle managers is said to be their

[11] It is worth noting that in later work, Burgelman (2002) also attributed Intel's success to the strategic vision of the CEO.

discursive competence in order to deliver such messages (Regnér, 2003; Rouleau, 2005; Maitlis & Lawrence, 2007; Rouleau & Balogun, 2011). The communicative capabilities of middle managers is important not only in terms of alerting top managers and key decision-makers to opportunities and threats, but also facilitating action around such issues through communication with the key stakeholders required, as a means to build or acquire, integrate and (re)configure the organization's resources and capabilities such that these issues can be exploited or addressed (Rouleau, 2005; Taylor & Helfat, 2009; Helfat & Peteraf, 2015). However, our understanding of how middle managers ought to frame and communicate novel technological opportunities to gain the attention and support of key decision-makers remains limited.

Given the consequences of cognitive inertia amongst managers (e.g. Burgleman, 1994; Rosenbloom, 2000; Tripsas & Gavetti, 2000; Eggers & Kaplan, 2009; Danneels, 2011), there has been much scholarly interest in how new frames and representations may be elicited, in order to facilitate innovation and change at incumbent organizations. Notable progress has been made with respect to the use of analogies and metaphors as ways in which managerial cognitive change can be stimulated (Gavetti, Rivkin & Levinthal, 2005; Clarke & Cornelissen, 2010; Gavetti & Menon, 2016). Managers can draw on prior and familiar experiences to form inferences about novel environments and adapt their cognitive frames, helping them manage the complexity and uncertainty in order to facilitate action (Gary et al., 2012; Vechiatto, 2020). There is empirical evidence that this has been effective at allowing managers to successfully interpret new products and services (Rindova & Petkova, 2007; Bingham & Kahl, 2013), as well as in the formation of new strategies for unchartered domains (Gavetti et al., 2005; Ott & Eisenhardt, 2020). Scholars suggest that the effectiveness of analogical reasoning depends on the degree of structural similarity between the source of the analogy and the target problem (Gick & Holyoak, 1983; Holyoak & Thagard, 1995; Vecchiato, 2020), where a lack of similarity past superficial features can result in inappropriate beliefs emerging about the target problem (cf. Gavetti & Rivkin, 2007). Similarly, irrespective of whether or not analogies allow frames to be updated or brokered, there are no assurances that these beliefs will be translated into action. The degree of uncertainty that is associated with novel technologies and solutions means that it is difficult for managers to ascertain whether or not they will be successful (Townsend et al., 2018). As such, failure looms large for managers in incumbent organizations, which can discourage and prevent them from acting (Healey & Hodgkinson, 2017). Questions therefore still remain regarding how managers may be motivated to act upon their newly formed cognitive representations.

Recently, scholars have shown interest in how emotion[12] affects the cognitive processes of managers and may motivate certain courses of action (e.g. Vuori & Huy, 2016; In-Press; Huy & Zott,

[12] Although scholars have only recently begun to engage with emotion in strategic management, it was evident in some of Herbert Simon's (1967) early work, where he drew inspiration from a number of other authors who directly cited the importance of emotion, such as Dewey (1922) and Commons (1934). Dewey (1922) argued that

2019). In psychology it has been established that what emotions individuals experience will impact how they subsequently think and act (Fiske & Taylor, 1991; Damasio, 1994; LeDoux, 2000) and this can be consequential for how managers make decisions. For example, Lerner and Keltner (2001) found that the experience of fear can make individuals more pessimistic in their risk estimates, and typically more risk-averse in terms of their choice, whereas people who are angry are relatively more optimistic in their risk estimates and more risk-seeking in their choices. Similarly, the experience of emotions like fear and anger has been shown to narrow the attention of actors as a means to identify, understand and respond to the eliciting stimulus (Russell, 2003; Damasio & Carvalho, 2013). Distorted perceptions of risk and narrowed fields of attention are likely to have consequences for the decision-making of managers in incumbent firms, making novel technologies and solutions look more or less appealing and accessible. Particularly novel technologies and solutions generally exist in distant domains (Gavetti & Levinthal, 2000; Gavetti, 2005) and thus if managers are cognitively impeded in their ability to explore such domains through emotions like fear, it can have the knock-on effect of preventing them from even identifying such opportunities. Emotion is also implicit in the political behaviours that actors may engage in, since jostling for power is ultimately motivated by a desire to influence the decision-making process in a way that favours themselves (Augier & March, 2008; Greve & Teh, 2018). Giving heed to the fact that cognition and emotion are fundamentally interrelated, scholars have begun to call for research which explores how emotion affects organizational decision-making and processes like innovation (Gavetti, 2005; Cohen, 2007; Gavetti, Levinthal & Ocasio, 2007; Hodgkinson & Healey, 2011; Powell et al., 2011; Gavetti et al., 2012; Healey & Hodgkinson, 2017; Brusoni et al., 2020). Despite the fact that emotion "colours information processing" (Gavetti, 2005, p.614) and is therefore consequential for the decisions that managers make, the innovation literature remains largely in a cold cognitive paradigm in which the role of emotion is marginalized at best, and ignored totally at worst (Hodgkinson & Healey, 2011; Healey & Hodgkinson, 2014). As such, our understanding of how emotion and cognition may interact and what the consequences are for incumbents with respect to their ability to innovate remains limited but demands further attention in order to provide accounts of innovation that are behaviourally plausible (Argote & Greve, 2007; Cohen, 2007).

2.2.3 Emotional factors

Given the limited understanding of how emotion affects the innovation process, the last decade has seen research on the topic burgeon as scholars set about addressing this gap. The primary purpose

theories of organizational actors needed to include and reflect the interplay between habit, emotion and cognition, the three key components of human psychology. Commons (1934) proposed that human behaviour and bounded rationality is heavily influenced by "stupidity, ignorance and passion" (p.874). Simon (1967; 1978; 1987) himself acknowledged that emotion had a certain degree of control over cognition and information processing, however as Kaufman (1999) points out, Simon's work remained almost purely cognitive and focused on bounded rationality through the limited capacity of the human mind (i.e. stupidity) and lack of knowledge (i.e. ignorance). The role of emotion (i.e. passion) remained conspicuously absent, which has been reflected in the subsequent lineage of work by behavioural theorists and indeed innovation scholars, until recently.

of emotion is to signal to an individual whether a stimulus is relevant to their present or future survival or wellbeing (Frijda, 1989; Lazarus, 1991a). As such, innovation is likely to trigger emotional responses in individuals and groups to the extent they perceive implications for themselves, positively or negatively. Since innovation involves the exploration of "what might come to be known" (March, 2006, p.205), it is inherently uncertain and therefore likely to evoke fear-based responses in organizational actors (Baumgartner, Pieters & Bagozzi, 2008; Huang, Souitaris & Barsade, 2019), as fear is elicited by uncertain and existential threats (Smith & Ellsworth, 1985; Lazarus, 1991a; Smith & Lazarus, 1993). Conceptual research suggests that the more novel the innovation, the greater the intensity the fear response will be, because it involves departures from known domains that managers may be comfortable with and attached to, into unknown and unfamiliar domains, which can prohibit innovation from taking place (Brusoni et al., 2020). An exemplar piece of work in this respect is Vuori and Huy's (2016) empirical investigation of fear at Nokia. They found that both top and middle managers at the organization experienced fear as they attempted to develop smartphones to compete with Apple and Samsung, and that this experience of fear caused dysfunctional patterns of communication between the levels of management, leading to a poor-quality market offering emerging. The failure was something Nokia never recovered from, leading to the divestment of their mobile phone division to Microsoft in 2013 (Healey & Hodgkinson, 2017; Lamberg, Lubinaitė & Tikkanen, 2019).

Relatedly, the threat-rigidity hypothesis (Staw et al., 1981) also suggests that fear is detrimental to the innovation process. While not ostensibly concerning fear, it is implicit in the threat-rigidity hypothesis given that (perceived) threats and dangers are the basis of the experience of fear (Lazarus, 1991a; Damasio & Carvalho, 2013). Staw et al. (1981) argued that external threats lead to inflexible organizational responses, the constricting of information processing and control systems, therefore limiting how organizations can behave and innovate (Gilbert, 2005). Zuzul (2019) offered a similar account, which although not solely focused on fear, found that the prevalence of negative emotions in a collaborative project created an atmosphere of distrust that derailed the project and caused it to fail. The emerging evidence from empirical studies seems to be that negative emotions are detrimental to the innovation process and ought to be avoided; however, this seems to contradict more conceptual accounts (e.g. Hodgkinson & Healey, 2011; 2014; Healey & Hodgkinson, 2017; Salvato & Vassolo, 2018). These accounts suggest that negative emotions may actually be a valuable source of information for managers regarding dangers and threats in their environment that require their attention and action. Additionally, more recent research on threat perceptions (Gilbert, 2005; König, Graf-Vlachy & Schöberl, 2021) has also suggested that perceptions of threat and experiences of fear might be beneficial by motivating action, but only in instances where actors perceive at least a moderate level of control over the situation they face (i.e. have the capacity to influence the outcome and avoid the threat). Accordingly, further investigation is necessary to establish the efficacy of claims made in the extant literature and resolve this discrepancy.

In light of threat perceptions causing rigid responses, scholars have suggested that innovations are better framed in terms of opportunities. Opportunity frames are thought to promote positive emotions, which are associated with more open-minded and flexible responses that can facilitate successful outcomes emerging from innovation (Amabile et al., 2005; Ravasi & Schultz, 2006; Kennedy & Fiss, 2009; Bartunek, Balogun & Do, 2011; Rindova, Dalpiaz & Ravasi, 2011; Bundy et al., 2017; Raffaelli, Glynn & Tushman, 2019). This idea is nested in the broaden-and-build perspective of positive emotions which suggests that positive emotions broaden cognitive processing, acceptance, and exploratory behaviours (Isen, 1999; Fredrickson, 2001). Research has shown that managers who can regulate both their own and others' emotions in order to enhance the prevalence of positive emotions, and minimize the prevalence of negative emotions, can gain access to the social resources necessary to seize innovative opportunities (Huy & Zott, 2019). Similarly, innovation implementation is more likely to be successful when employees experience positive emotions towards the innovation (Choi et al., 2011). These findings all support the idea that positive emotions are beneficial for innovation.

Bridging the gap between positive and negative emotional experiences is the notion of emotional ambivalence, which is defined as the simultaneous experience of positive and negative emotions towards an object or course of action (Fong, 2006; Rothman & Wiesenfeld, 2007; Ashforth et al., 2014; Rothman et al., 2017). Intuitively it would seem that the experience of mixed emotions might constrain innovation as actors try to reconcile 'what is going on' which would distract them from the task at hand. This is a position that Raffaelli, Glynn and Tushman, (2019) espouse in their conceptual work on Blockbuster and Netflix, whereby ambivalence is seen as a potential root of resistance. However, Fong (2006) found that when consciously experienced, ambivalence can promote creative thinking: the peculiar nature of ambivalence allows actors to make connections that they would not otherwise be able to make, a finding which has been echoed by others (George & Zhou, 2007). With creativity being the basis for innovation (Anderson, Potočnick & Zhou, 2014), ambivalence may thus constitute a way in which organizations can improve their capacity to innovate. Plambeck and Weber (2009; 2010) found evidence that the experience of ambivalence amongst top managers can improve the quality of their decision-making and lead to improved outcomes for the organization. While it seems likely that mixed emotions are likely to be experienced in the innovation process, and may have consequences for how it can be carried out, there is limited empirical investigation on this topic. As ambivalence is a concept that has been integrated from psychology (Rothman et al., 2017), many studies have utilized experimental designs (e.g. Fong, 2006; Rothman, 2011) and although these have provided interesting insights, question marks still remain over their real-world efficacy, indicating a need for more naturalistic styles of investigation on the topic, such as case studies.

2.2.4 Emotion in organizations more broadly

The interest in how emotion affects the innovation process is still relatively new, and as such our insight on the topic is somewhat limited. However, there has been work in adjacent fields looking at how emotions affect organizational change more generally. This is relevant to this thesis, given that innovation can be conceptualized as a form of organizational change. Since change generally alters strategy, identity and/or work roles, it is often of personal relevance to organizational actors and thus triggers emotional reaction (Bartunek, 1984; Huy, 1999; Elfenbein, 2007). Whether change is successful or not has therefore been linked to the emotions that organizational employees experience (Huy, 1999), where negative emotional reactions to change can manifest as resistance and prevent it from being successful. Middle managers occupy a particularly important position because they can exert both upwards and downwards influence on superior and subordinates, and therefore have a significant capacity to influence the emotions, thoughts and behaviours of a wide range of actors. In this respect, scholars have begun to emphasise that middle managers must have the capability to regulate their own emotions, as well as the emotions of others (Huy, 2002; Shepherd, 2003; 2004; Sy, Côté & Saavedra, 2005), since this can be a critical determinant of success or failure. A recent study by Vuori and Huy (In-Press) explored socially distributed emotion regulation at Nokia, reiterating how important it is for the emotions of top managers (as well as other organizational actors) to be carefully regulated, in order to facilitate successful radical strategic change.

The effective management of group-level emotions has become particularly salient, given the trend towards social interdependencies in organizations and workplaces (Kelly & Barsade, 2001; Barsade, 2002; Barsade & Gibson, 2007). However, what emotions groups come to experience is complex: as Cyert and March (1963) pointed out, organizations consist of numerous groups and actors all with their own goals and interests. Appraisals of what change means will therefore differ between groups, as they interpret it in terms of different goals and interest. This means that a multitude of emotional responses can emerge (Ellsworth & Scherer, 2003). In this manner, a valuable management capability is emotional aperture (Sanchez-Burks & Huy, 2009) which is the ability to accurately perceive various shared emotions that exist within a collective. Such understanding can allow managers to engage in appropriate emotion regulation strategies that can bring about desirable and productive outcomes (Gross, 1999; Huy, 2002; Gross & John, 2003; Zott & Huy, 2019). Research has also linked the emotions experienced by organizational members, with their judgements of legitimacy; in turn, this can impact whether or not employees resist change or not (Huy, Corley & Kraatz, 2014). Scholars have spoken about the importance of an organization's emotional energy with regards to change, whereby negative emotions are often seen as inhibitory (Pratt & Dutton, 2000; Fiol & O'Connor, 2002), which highlights why it is important for managers to be able to accurately perceive emotions, such that they can act in a way that can facilitate desirable outcomes.

Contributing towards the organization's emotional energy is how organizational actors express their emotions, since emotional expressions can influence the behaviour of others and thus have an amplification effect (Barsade, 2002; Niedenthal & Brauer, 2012). For example, employees facing external threats may share their concerns with their team, leading to constructive patterns of communication that can allow the threat to be addressed (Lebel, 2016; 2017). Lebel (2016; 2017) offers an alternative account to that of Vuori and Huy (2016) where the experience of fear led to a breakdown in communication channels, and Zuzul (2019), where negative emotions created dynamics precluding collaboration. He argues that a more contingent perspective should be taken, and whether positive or negative outcomes emerge will depend on the context. Accordingly, there is a need to re-examine how fear affects organizational processes like innovation. The prevalence of negative emotions has also been explored in the context of the post-acquisition integration process, where it has been found to lead to sub-optimal outcomes (Graebner et al., 2017), even when these negative emotions are suppressed or masked (Vuori, Vuori & Huy, 2018).

Institutional scholars have also showed a growing interest in emotion, exploring how they can serve to maintain or change the institutional order (Toubiana, Greenwood & Zietsma, 2017). Organizational environments are made up of multiple logics that co-exist, to which actors will have differing levels of emotional attachment (Creed, Dejordy & Lok, 2010). Logics have their own "emotional register" (Toubiana, Greenwood & Zietsma, 2017, p.944), which determines what constitutes the legitimate use and expression of emotions. Accordingly, institutional logics will condition what emotions people come to experience and express (Voronov & Weber, 2016; Gill & Burrow, 2018). These emotional registers can be seen as a form of expectations that, when violated, may result in organizational actors who remain committed to that logic to experience emotions like betrayal (Voronov & Vince, 2012) and anger (Creed et al., 2014). Such emotions can motivate institutional maintenance work that tries to restore these violated expectations (Toubiana & Zietsma, 2017; Zietsma & Toubiana, 2018). There has also been interest in how emotions might be evoked to influence, or simply involved in, legitimacy judgments (Meyer & Rowan, 1977). Positive emotions can lead actors to construe objects, people and actions as legitimate (Haack, Pfarrer & Scherer, 2014), and thus there may be active efforts to elicit either positive or negative emotions in target audiences in order to (de)legitimate a course of action (Lefsrud, Graves & Phillips, 2020).

There has also been recognition of the existence of mixed emotions and/or cognitions in organizational life[13]. Pratt's work on Amway (Pratt & Barnett, 1997; Pratt, 2000) highlighted how the organization proactively fostered strong conflicting emotions amongst new recruits as a way of

[13] Ashforth et al. (2014) argue that distinguishing between cognitive and emotional ambivalence is somewhat of a false dichotomy, given that emotion and cognition are intertwined. However, this review focuses on ambivalence caused by conflicting emotions and/or cognitions. I do not consider ambivalent identification (e.g. Eury, Kreiner, Trevīno & Gioia, 2018), as this relates to the identification literature, which is not relevant here.

facilitating learning and commitment to the organization. In this manner, ambivalence was sought-after because it behaved as an effective mechanism for cognitive change. Pratt and Rosa (2003) found that network marketing organizations transformed ambivalence around work-family into high levels of commitment to the organization through practices and activities focused on reducing the negative emotions members experienced. In a similar respect, ambivalence has been linked to the levels of resistance that organizations experience when attempting change (Meyerson & Scully, 1995; Piderit, 2000; Raffaelli, Glynn & Tushman, 2019), as it is said to lead to the formation of resilient forms of trust (Pratt & Dirks, 2006). Naomi Rothman's work (Rothman, 2007; 2011; Rothman & Wiesenfeld, 2011) has highlighted how the social expression of ambivalence can have a number of consequences at both the individual and group level. For example, individuals who express ambivalence are likely to be seen as indecisive, less competent, and impulsive, which can be consequential for their ability to effectively manage in organizations (Rothman & Wiesenfeld, 2011). Rothman (2011) also reported that those who socially demonstrated ambivalence in inter-dependent decision-making contexts are likely to be seen as submissive, which encourages observers to exhibit dominant behaviours and take charge of the situation. This obviously has implications for the outcomes of the decision-making process, but it is worth noting that this work was conducted as a laboratory experiment where there was a focus on the expressed ambivalence of an actor. Outside of this context whether or not these findings hold may depend on the ability of actors to recognize the expressed emotions of others. An interesting real-world example of ambivalence reported by Pradies and Pratt (2010) was the vacillating response by Microsoft Corporation's leadership team towards the gay-rights bill in the United States. They noted that Microsoft's leaders initially shown support for the bill, before removing support, then reinstating support, all on the basis of discrepant support within the organization. Organizational life is characterised by a blend of emotions (Scherer & Tannenbaum, 1986) and the literature on mixed emotions in particular has shown how these can have a variety of positive and negative effects.

2.3 The psychology of emotion

Over the last half century, there has been much contestation over exactly what emotions are and what their purpose might be. That said, there is broad agreement amongst scholars that emotions are interfaces that exist between an organism and its environment (Mulligan & Scherer, 2012). Emotions can be seen as adaptive responses to the demands of the environment (Scherer, 1984; Smith & Ellsworth, 1985; Lazarus, 1991a; Ekman, 1992) which aim to improve the perceived person-environment fit through a range of actions and responses (Frijda, 1988; Smith & Lazarus, 1993). The term 'emotion' derives from the Latin *pro-motionem* which can be translated as 'to move forwards,' reflecting their evolutionary nature as a response to survival challenges (Darwin, 1872; Menges & Kilduff, 2015). Emotions can be delineated from moods on the basis of the intensity of the experience, its duration and whether an eliciting stimulus is present or not (Elfenbein, 2007). Generally speaking, emotions are seen to be discrete, short-lived and intense experiences where there is a clear eliciting

stimulus or 'target' (Ellsworth & Scherer, 2003), whereas moods are longer and more diffuse in nature without a clear eliciting stimulus; moods can be brought about by stimuli of low intensity, or emotions where the target has faded in salience (Cropanzo, Weiss, Hale & Reb, 2003). Emotion and mood are often grouped together under the umbrella term of 'affect' (Forgas, 1995). In this thesis, I follow other scholars in the strategic management field (e.g. Vuori & Huy, 2016; In-Press; Vuori, Vuori & Huy, 2018) and define emotion as an intrapersonal process which begins when "a focal individual is exposed to an eliciting stimulus, registers the stimulus for its meaning, and experiences a feeling state and physiological changes, with downstream consequences for attitudes, behaviours, and cognitions, as well as facial expressions and other emotionally expressive cues" (Elfenbein, 2007, p.315).

Table 2.1 - Differentiation of emotions and moods (adapted from Elfenbein, 2007)

	Emotion	**Mood**
Eliciting Stimulus	Clear and identifiable	May not be known
Intensity	High levels of arousal	Low levels of arousal
Duration	Short-lived	Longer periods of time

2.3.1 Perspectives on emotion

Scholars have offered a number of different perspectives on the nature of emotions, which can be broadly delineated as Evolutionary, Somatic or Cognitive accounts (see Table 2.2 for an overview). Evolutionary accounts of emotion can be traced back to Darwin (1872), the fundamental premise being that emotions have evolved as a form of adaptive response which allow humans and animals to response quickly to stimuli within their environment in order to both survive and reproduce. As Nesse (1990) summarizes, "emotions can be explained as specialized states, shaped by natural selection, that increase fitness in specific situations" (p.261). This requires that humans and animals "adjust [their] physiological, psychological, cognitive and behavioural parameters" (Tracy, 2014, p.308) in order to effectively adapt and respond to threats and opportunities in their environments. Each emotion can be seen as a distinct form of adaptation for a specific problem (Tracy, 2014), which allows organisms to effectively organize and orchestrate the various components of their cognitive architecture as required to respond appropriately to the situation at hand (Cosmides & Tooby, 2000). Specifically, evolutionary theorists would argue that emotions arise "when issues of survival are raised in fact or by implication" (Plutchik, 2001, p.346). Broadly speaking, positive emotions indicate that an environment is safe, advantageous or that there is a reward available, whereas negative emotions convey that the environment or situation at hand is dangerous and threatening (Fisher, 2019), and this understanding of whether a situation presents either opportunities or threats allows organisms to effectively adapt and respond in a manner that enhances their chance of surviving and thriving. Evolutionary theories have also suggested that emotions have distinctive universal signals, many of which are physically

discernible through facial expressions (e.g. Ekman, 1972; Tomkins, 1984; Izard, 1993) as well as other motor behaviours like posture, eye movement and vocalizations (Ashkanasy & Dorris, 2017). The evolutionary perspective can therefore be delineated into two schools: a traditional evolutionary perspective (Ekman, 1972; 1992), which explores seven 'basic emotion' families (disgust, fear, anger, surprise, sadness, happiness, contempt) and focuses relatively specifically on survival as an adaptive problem, as well as an evolutionary psychological perspective (Cosmides & Tooby, 2000; Tooby & Cosmides, 2008) which has explored a larger number of emotions, focused on a broader range of adaptational problems and looked at emotions more specific to humans.

From a somatic perspective, emotions are determined by bodily responses rather than cognitive interpretations. William James (1884; 1890) work on emotion can be seen as the earliest somatic account, although similar assertions were made independently of James' work by Carl Lange (1885), leading to the emergence of the James-Lange theory of emotion. This suggests that environmental stimuli lead to automatic responses in the autonomic nervous system, which in turn lead to emotional experiences in the brain according to how the individual in question interprets their physical responses. Crucially, the James-Lange theory argues that physiological arousal comes first, and that it is how this is interpreted which determines what emotion an individual will experience, an idea that has more recently been supported by Antonio Damasio (1994). As put succinctly by Barrett and colleagues (2007), such physiological accounts presuppose that "specific emotions result from the perception of specific and unique patterns of somatovisceral arousal" (p.379). The James-Lange model has, however, been heavily critiqued. During the 20th Century, psychologists Walter Cannon (1927) and Phillip Bard (1973) argued that emotions do not necessarily follow physiological arousal but rather emotions and physiological changes occur simultaneously via different thalamic pathways. Cannon (1927) in particular argued that the autonomous responses suggested by the James-Lange theory lack specificity (i.e. the same physical responses exist in cases of fear and anger); that emotions cannot be induced through artificial arousal; and that disrupting the feedback process (e.g. disconnect organs from the central nervous system) did not eliminate emotions from being experienced (Moors, 2009). Schachter and Singer (1962) attempted to reconcile the accounts of James and Cannon with a Two-Factor model of emotion; like James and Lange, they felt that physiological arousal did play a role in emotion, and thus the first stage of their model consisted of an undifferentiated state of physiological arousal. However, Schachter and Singer suggested that individuals engage in a process of interpretation to explain and label their feelings; should individuals not have an adequate explanation for their emotion, the model proposed that they would draw upon external cues as a way of inferring their internal emotional state (Elfenbein, 2007). It is thus the cognitive process of attribution rather than arousal itself which brings about emotional experiences.

The Schachter-Singer model highlights the role that cognition can play within the emotion process, offering a segue to discuss cognitive models of emotion, which have proven to be a bountiful

area of research since the 1950s. Cognitive accounts have largely assumed the label 'appraisal theories' as coined by Arnold (1960), who argued that prior research had failed to explain how exactly emotions were elicited. Arnold (1960) introduced the idea of appraisal, a cognitive process through which the significance of an environment could be determined for an individual, which would lead to the elicitation of certain emotions as a consequence. From the cognitive perspective, "thinking and feelings are inextricably linked" (Ellsworth & Scherer, 2003, p.572) and – similar to Schachter (1962) – it is through our analysis of cues within our social environments that we come to experience emotions (Lazarus, 1991a; 1991b). Arnold (1960) initially proposed an appraisal theory with three primary dimensions, which was subsequently built upon by the likes of Lazarus (1966; 1991a), Smith and Ellsworth (1985), Frijda (1986), Scherer (1984), Roseman (1984), Clore and Ortony (2000) and Ellsworth (1991; 2013) to offer a variety of different appraisal theories, each with their own set of appraisal questions under slightly different labels. Although this has led to contention over the exact content and sequence in which appraisal takes place, broadly speaking there is coherence amongst appraisal theorists over the basic tenets of emotions. For example, there is agreement that individual appraisals do not constitute emotions, which are a multi-componential phenomenon, but are the most important component within this process (Scherer & Moors, 2019). It is through the appraisal process that emotions are differentiated and change other components, thus playing a hand in what action tendencies, physiological responses, behaviours and feelings emerge (Clore & Ortony, 2000; Scherer, 2001; Roseman & Smith, 2001; Frijda, 2007). Following evolutionary accounts (Darwin, 1872), appraisal theorists agree that emotions are adaptive solutions that emerge based upon the perceived (potential) satisfaction or obstruction of concerns (Frijda, 1986; 2007), where concerns regard an individual's needs, attachments, values, goals and beliefs (Frijda, 1986; Lazarus, 1991a; Scherer, 2004). Similarly, the appraisal process is generally automatic and not necessarily conscious – in contrast to Schachter's (1964) model – however it is accepted that the appraisal process can, at times, proceed non-automatically (Moors et al., 2013). It is also accepted that emotions may arise from stimuli that are immediate, imagined or remembered (Ellsworth & Scherer, 2003), highlighting the role of both retrospection and prospection in the emotion process (Wilson & Gilbert, 2005; Dane & George, 2014).

Table 2.2 - Summary and comparison of different perspectives on emotion

	Evolutionary	**Somatic**	**Cognitive**
Key theorists & work	Darwin (1872) Ekman (1972) Tomkins (1984) Nesse (1990) Izard (1993) Cosmides & Tooby (2000)	James (1884) Lange (1885) Cannon (1927) Bard (1973) Damasio (1994) Prinz (2004)	Arnold (1960) Schachter & Singer (1962) Scherer (1984) Roseman (1984) Smith & Ellsworth (1985) Frijda (1986) Lazarus (1991a; 1991b) Clore & Ortony (2000)
Emotion process	When individuals face an issue of survival – either directly or implied – a specialized adaptive response which involves reconfiguration of the physiological and psychological architectures will be triggered in order to respond appropriately to the situation at hand.	Early accounts suggested that physiological arousal and bodily responses preceded and determined what emotion was experienced. Later models found that physiological arousal did not solely determine emotion but occurred simultaneously via different pathways. Physiological arousal could play a role in determining emotions, though, as individuals interpreted and sought to explain and labelled their feelings.	Individuals interpret their environment according to a number of appraisal dimensions, which determine whether their relationship with the environment is (in)conducive to meaningful goals or outcomes they hold. The nature of this appraisal – and the appraisal profile generated – determines the emotion experienced. Subsequently, action tendencies (involving both psychological and physiological adaptations) are triggered, providing the basis for an individual to act.
Distinctive feature(s) or thoughts	Emotions are a set of adaptive responses that have evolved through a process of natural selection. Emotions have distinctive universal signals which are often physically discernible.	Physiological arousal, rather than cognitive appraisal, is central to emotion. That is, the physical component is the critical component in the emotion process. The pattern of physiological arousal determines what emotion is experienced.	While thinking and feeling are intrinsically linked, cognition is the key component in the emotion process which determines what emotion is experienced. Emotion is determined through cognitive appraisals of the environment, in terms of the environment's (in)conduciveness to fulfil the meaningful goals of a given individual . Emotion is therefore inherently subjective.

In this thesis, I follow others in the field of management (e.g. Huy, 2011; Huy, Corley & Kraatz, 2014; Vuori & Huy, 2016; Vuori, Vuori & Huy, 2018; Vuori & Huy, In-Press) and build on the appraisal perspective of emotions. Specifically, I draw upon the theories proposed by Smith and Ellsworth (1985) and Lazarus (1991a). Through appraisal theory it is possible to reconcile cognition with emotion because the fundamental premise of this approach is that emotion is determined and experienced according to the cognitive appraisals that individuals make (Ellsworth & Scherer, 2003). This will allow me to build on and extend the purely cognitive approaches that have been prevalent in research on organizational decision-making and innovation (Gavetti, 2005; Hodgkinson & Healey, 2011; 2014; Gavetti et al., 2012), illustrating how the cognitive and emotional recursively interact with one another and thus incorporating affect into accounts of innovation. Leveraging the insights from both Lazarus (1991a) and Smith and Ellsworth (1985) also provides an effective scaffold through which emotion can be identified in qualitative data: texts can be analyzed and interpreted according to the appraisal dimensions put forward by both sets of scholars as a way of determining implicit instances of emotion. Where sections of text are coded by both perspectives elicit the same emotion, this will offer a high level of confidence that the emotion identified is exactly that. Lazarus' (1991a) notion of 'core relational themes' summarises the essence of each emotion in terms of its person-environment relationship, thus providing me with a way to quickly identify emotions on first reading. Additionally, Smith and Lazarus in fact collaborated on a number of pieces of work (e.g. Smith & Lazarus, 1988; 1990; 1993), which is evidence of the similarity in their thoughts on the nature of emotions and the emotional experience (see Table 2.5 for an overview).

2.3.2 The emotion process according to Lazarus, Smith & Ellsworth

Richard Lazarus' (1966; 1991a; 1991b; Lazarus & Folkman, 1984; 1987) work on emotion and stress has emphasised that emotion is generated by changes in the relationship between person and environment, leading to a Cognitive-Motivational-Relational model of emotion. Individuals appraise the situations that they find themselves in (cognitive), considering their person-environment relationship (relational) and whether or not this is harmful or beneficial for them (motivational), leading to the emergence of emotions and moods as a way of adapting (Lazarus, 1991a). When situations are deemed to have a (potential) source of benefit, individuals experience positive emotions that motivate them to sustain or enhance their person-environment relationship; negative emotions indicate a (potential) source of threat or harm and thus motivate actions which can ameliorate or improve the person-environment relationship. In this way, emotions are adaptational resources (Smith & Lazarus, 1990). Each emotion therefore has its own distinct pattern of appraisal, as well as action tendencies designed to sustain or improve the person-environment relationship to enhance the individual's wellbeing (Lazarus, 1991a). Each emotion can also be summarized by a unique core relational theme, which conveys the nature of the person-environment relationship (Lazarus, 1991a; Smith & Lazarus, 1993).

The appraisal process according to Lazarus (1991a) occurs in two stages, and involves six dimensions or components (i.e. questions that are asked or evaluated within appraisal), though it should be noted that this was not steadfast (for an overview, refer to Table 2.3). Lazarus himself acknowledged four dimensions could be effective for differentiating between emotions, whilst he was involved in a number of other publications which offered slight variations on the dimensions and process of appraisal (see Smith & Lazarus, 1990; 1993; Smith et al., 1993). Each stage of appraisal addresses one of two issues relevant to well-being, as identified by Lazarus and his colleagues (Lazarus, 1966; Lazarus et al., 1970; Lazarus & Folkman, 1984). Primary appraisals are concerned with whether or not a situation or stimulus is relevant to an individual's goals, well-being or values, whilst secondary appraisals consider an individual's capacity to cope with the situation they face (Smith & Lazarus, 1990). Both primary and secondary appraisals can be further broken down in terms of specific questions that they address.

The purpose of primary appraisals is to determine the personal stake that an individual might have in an outcome, and thus the first question asked is goal relevance. Whether or not an individual cares about the situation or has anything at stake is important, because emotions are only evoked when the circumstances are relevant to an individual's goals or well-being. When a situation is appraised as not relevant, no emotion will follow (Smith & Lazarus, 1990). The question of goal relevance has also been included in a number of other appraisal theories (e.g. Scherer, 1984; Smith & Ellsworth, 1985; Frijda, 1986). When a situation is considered goal relevant, the next question considered is whether it is goal congruent; is the encounter congruent (i.e. beneficial to) or incongruent (i.e. harmful to) with an individual's goals, values or beliefs? Goal congruence determines whether an emotion is positive (i.e. pleasant) or negative (i.e. unpleasant), and again corresponds with the appraisal dimensions of motive consistency (Roseman, 1984), goal conduciveness (Scherer, 1984) and perceived obstacle (Smith & Ellsworth, 1985). Lazarus (1991a) also considers goal content or ego involvement (Lazarus, 1992) as another component of primary appraisal, referring to the type of goal at stake in a given scenario, although this dimension is absent other than for fleeting reference in other publications (e.g. Smith & Lazarus, 1990; 1993). In Smith and Lazarus (1993), this issue is directly addressed; whilst Smith did not see goal content as something central to the differentiation between different forms of emotion, Lazarus maintained that the type of goal involved was crucial to differentiating between certain emotions; for example, guilt and shame can be differentiated through the type of goal of value at stake, the former involving a moral value, the latter an ego ideal (Smith & Lazarus, 1990).

Secondary appraisals determine the options and prospects of an individual to cope with the situation they face; this stage may also be seen as what differentiates between different (un)pleasant states and elicits specific emotions. In his 1991a publication, Lazarus suggested that secondary appraisal takes into consideration an individual's coping potential, accountability (i.e. who is responsible for the threat or benefit), and future expectancy (i.e. what is expected to change or happen in the future). Accountability closely resembles concepts of causality (e.g. Smith & Ellsworth, 1985; 1988a; 1988b)

and determines who is to receive either credit or blame for the circumstances that an individual faces, thus providing the emotional experience with a direction and focus, guiding the coping strategies deployed in response. Implicit in statements of accountability are control; if the person who is held accountable could have done otherwise then they will be deemed to have acted maliciously, stirring up feelings of reticence (Smith & Lazarus, 1990). Coping potential and future expectancy are both evaluations of whether or not the situation can be improved (if undesirable) or maintained (if desirable). Specifically, coping potential derives from prior work on stress that was carried out by Lazarus and Folkman (Folkman & Lazarus, 1980; 1985; Lazarus & Folkman, 1984). They identified that individuals can broadly try and cope with situations they face by psychologically altering the situations they face through either attentional deployment or changing the meaning of the situation (emotion-focused coping); in this manner, individuals can regulate the emotions that they experience[14]. Alternatively, individuals may be able to directly act on the situation at hand to alter the person-environment relationship (problem-focused coping). Both emotion- and problem-focused coping aim to either sustain or alter the meaning of the situation at hand, which provides them with the capacity to regulate the emotions they experience (Lazarus, 1991a; Smith & Lazarus, 1990; 1993). Coping potential[15] corresponds to the notion of power in Roseman's work (1984), whilst in Scherer (1982), problem-focused coping maps to his concept of control and power, whilst emotion-focused coping resembles the potential for adjusting via internal restructuring. Future expectancy refers to the possibility that for any reason, independent of the individual's efforts, the situation might change in a way that made it more or less desirable (i.e. change in goal congruence).

Table 2.3 - Overview of the emotion process according to Lazarus (1991a)

Stage of Process	**Purpose**	**Component**	**Purpose**
Primary Appraisal	Determine whether or not an emotional response is warranted, and whether it will be positive or negative in nature.	Goal relevance	Establish whether or not the stimulus or current circumstances are relevant to individually meaningful goals, beliefs or values. Emotions are only experienced if the situation has relevance to individual goals or wellbeing.
		Goal congruence	Determine whether the stimulus or circumstances are pleasant or unpleasant (i.e. establish their congruence with personal goals and wellbeing).

[14] An in-depth discussion of emotion regulation is beyond the scope of this study. For those interested, see Gross (1998; 2013; 2015) for detailed discussions on the topic.

[15] It is worth noting that whilst Lazarus (1991a) simply specified about coping potential, his work with Craig Smith (Smith & Lazarus, 1990; 1993) differentiated between problem-focused and emotion-focused coping potential. The reason for this discrepancy was that Smith saw the differences as important to distinguishing between sadness and fear, whereas Lazarus believed that it did not matter how individuals changed the situation but that they could do so in the first place (Smith & Lazarus, 1993).

		Goal content	What type of goal is at stake in a given scenario.
Secondary Appraisal	Distinguishes between what type of positive (pleasant) or negative (unpleasant) emotion is experienced, on the basis of an individual's capacity to cope with the situation that they face.	Coping potential	Identifying whether or not it is possible to improve or maintain the situation through psychological mechanisms like attention adjustment or altering the meaning of the situation (i.e. changing goals, values, beliefs), or – alternatively – taking action to directly adjust the situation faced. This action may be undertaken personally, or through the resources and network that an individual possesses or has access to.
		Accountability	Establishing who is responsible for the situation, and thus who should receive credit or blame.
		Future expectancy	To establish whether or not the situation or circumstances will change for any reason, independent of an individual's direct efforts to change it, to become more or less goal congruent.

Smith and Ellsworth (1985) – like Lazarus – offered their own appraisal theory of emotion following and building upon work by Scherer (1982; 1984) and Roseman (1984). Their model included eight appraisal dimensions, taking into account *attention, pleasantness, control, certainty, perceived obstacle, responsibility, legitimacy* and *anticipated effort* (see Table 2.4 for an overview). As illustrated by facial expression theorists (e.g. Tomkins, 1962; Ekman, 1984) *Attention* is an important aspect of emotion: whether attention is paid to a stimulus or not is fundamental to whether it can evoke an emotional response or not. Though other appraisal theorists do not generally include a dimension for attention, it is arguably reflected in dimensions like novelty (Scherer, 1982), which refer to whether a stimulus or event follows or violate expectations. Generally, when something violates expectations (i.e. highly novel) it demands attention. There also bares similarity to the dimension of *Certainty*; reflecting the same dimension in Roseman's work (1984), Smith and Ellsworth (1985) acknowledged that attention and certainty are likely to be correlated, given that uncertain situations are unpredictable and thus demand more attention naturally. However, they opted to distinguish between the two in order to allow them to explore peculiar cases (i.e. where uncertainty is high but attention is low, or vice-versa).

Pleasantness refers to whether a stimulus is intrinsically pleasant or unpleasant, but as Scherer (1982) points out, this appraisal may depend on the relevance of the stimuli to goals: something can be inherently pleasant but because it interrupts plans related to goal attainment, it may be appraised as

unpleasant. Pleasantness corresponds with the dimension of goal congruence in Lazarus (1991a), under the auspices that something is construed as (un)pleasant depending on whether or not it is congruent with an individual's goals. Smith and Ellsworth (1985) also include a dimension called *Perceived Obstacle* which reflected whether or not a stimulus was (in)conducive to desired goals, and how a stimuli that was on the surface pleasant and desirable could be seen as unpleasant and undesirable if it was in the way of something desirable. In this way, it holds similarities to Lazarus' (1991) notion of goal relevance, but whilst Lazarus maintained that something goal irrelevant would not stimulate an emotional response, Smith and Ellsworth suggested that the presence of a goal irrelevant stimuli could contribute towards an emotional experience.

Smith and Ellsworth (1985) included a dimension of *Control* in their model, mirroring both Roseman (1984) and Scherer (1982), as well as Lazarus (1991a), control corresponding with his dimension labelled coping potential. Smith and Ellsworth posed that individuals will evaluate their ability to cope with (i.e. control) the situation they face, determining whether it is controlled by themselves, by another person, or by impersonal circumstances (e.g. nature).

Responsibility resembles accountability in Lazarus (1991a). Though similar to control, Smith and Ellsworth (1985) point out that an individual may trigger a situation by way of a derogatory comment, for example, but then cease to control that situation, and therefore it is necessary to distinguish between the two. *Legitimacy*, corresponding with the same dimension in Roseman (1984), refers to whether or not an outcome is considered to fair or (un)deserved, often in light of social norms as well as personal standards and expectations. This idea is reflected by Scherer (1982) in his concept of norm and self-concept compatibility.

Finally, Smith and Ellsworth (1985) consider the level of arousal or intensity of emotion in their dimension of *anticipated effort*. Organisms take into account whether they will have to engage with a stimulus, or whether they can withdraw and relax, and thus anticipated effort exists on a scale of high to low, with tinges of Cannon's (1929) fight or flight principle evident.

Table 2.4 - Overview of emotion process according to Smith & Ellsworth (1985)

Appraisal Dimension/Component	Purpose
Attention	Emotions are only caused by events/stimuli that demand attention. Whether attention is gained generally depends on whether or not they violate expectations (i.e. how novel the situation is). This dimension was distinguished as either attend to or shut out/ignore.
Certainty	How certain-vs-uncertain is the outcome? Is it understood, uncertain or predictable?
Pleasantness	Degree to which a circumstance is pleasant-vs-unpleasant depends on appraisal of what one has versus what they do not have, but want.
Perceived Obstacle	Perception of something standing in the way of achieving a desired/required outcome.
Control	In assessing ability to cope with a situation, individuals must determine who is in control of the situation. This could be the self, another human, or the environment.
Responsibility[16]	Who is responsible for the situation being experienced? The responsible party can be human (self or other) or potentially the environment. Responsibility is closely related to the dimension of Control, but are distinct because someone may initially create a situation but then cease to be in control of it.
Legitimacy	Whether the current circumstances are deserved or undeserved – an assessment of whether the outcome is fair, or whether a party has been cheated.
Anticipated Effort	Assessment of level of activation required (low to high) in order to act upon the current circumstances.

The models as proposed by Lazarus (1991a) and Smith and Ellsworth (1985) are more similar than first impressions may suggest, most surface differences attributable to the use of different labels (see Table 2.5). That said, there are intricacies of both approaches, such as the consideration of likely future changes in circumstance by Lazarus, or by the perceived legitimacy or fairness of the outcome by Smith and Ellsworth. Accordingly, the combination of the two together allows for greater confidence in the emotion identified than is possible using either in isolation. Importantly, both sets of scholars agree that discrete emotions correspond with specific appraisal profiles, and it has been established that the appraisal profiles offered by each set of scholars has a high level of correspondence with one another (see Table 2.5). For example, the experience of fear is triggered by high levels of uncertainty and

[16] Control and Responsibility are both important to determine agency (Smith & Ellsworth, 1985; Ellsworth & Smith, 1988) but could be subsumed under one single heading if required. Indeed, in Ellsworth and Smith (1988) they often talk of agency rather than either variable individually.

existential threat, which is controlled by another and against which the individual has a low or unknown capacity to cope.

Table 2.5 - Comparison of Appraisal Theories as proposed by Lazarus (1991a) and Smith & Ellsworth (1985)

	Lazarus (1991a)	**Smith & Ellsworth (1985)**
Proposed Appraisal Dimensions	*Primary Appraisal* Goal relevance Goal congruence Goal content *Secondary Appraisal* Accountability Coping potential Future expectancy	Attention Certainty Pleasantness Perceived Obstacle Control Responsibility Legitimacy Anticipated Effort
Similarities	*Goal relevance* in L largely fulfils the same purpose as *Attention* in S & E; When something is not goal relevant, it does not demand or warrant attention, and both behave as the initial step in the respective emotion processes. L's dimension of *Goal congruence* fulfils the same purpose as S & E's dimensions of *Pleasantness* and *Perceived Obstacle:* These dimensions consider whether the environment is conducive (or not) to achieving goals or maximizing wellbeing, which determines whether the emotion experienced is positive or negative. Accountability in L maps to Responsibility in S & E; Both dimensions are concerned with who has caused the stimulus in the environment. *Coping potential* in L broadly corresponds to *Control* in S & E; *Coping potential* refers to the capacity of the individual to cope with the situation at hand through acting on it or psychological adjustment. *Control* refers to whether or not an individual can control a situation; in some circumstances, it is beyond their capacity to do so because someone else may control the situation, or the situation may be controlled by mother nature (e.g. during a storm). *Coping potential* in L also broadly corresponds with *Certainty* in S & E; L highlights how fear is elicited as a result of uncertainty over whether or not the individual will be able to cope. Although S & E talk of certainty in terms of how much attention will be drawn, implicit in this discussion is that uncertainty often demands attention as a way of determining how best to respond.	
Differences	*Anticipated Effort* in S & E is absent in L; S & E (1985) acknowledge that few other appraisal theorists differentiate between the level of arousal or intensity involved in the emotional experience, but rather treat this implicitly. *Legitimacy* – or fairness of the outcome – in S & E is absent in L. *Goal content* in L is absent in S & E. *Future expectancy* in L is absent in S & E.	

2.3.3 The experience of fear

An emotion that is likely to be prevalent and important in the pursuit of novelty and innovation is fear, given uncertainty is central to the experience of fear and characterises the pursuit of forms of novelty (Baumgartner, Pieters & Bagozzi, 2008; Huang, Souitaris & Barsade, 2019). Fear is a discrete, negatively valenced emotion which is evoked when actors appraise threats or dangers in their environment, which they have believe they have a limited or uncertain capacity to manage or address (Gray, 1971; Lazarus, 1991c).

Whilst uncertainty is also a central feature in the experience of emotions like surprise, fear involves appraisals of threat and low coping potential, and thus the perception of potential danger or harm. It is therefore an unpleasant experience motivating avoidance, whereas surprise is often said to be hedonically neutral, its valence depending on whether the unexpected stimuli responsible for surprise is motivationally congruent or incongruent (Lazarus, 1991c; Lerner, Yi, Valdesolo & Kassam, 2015; Reisenzein, Horstmann & Schützwhol, 2019). Surprise is also said to motivate approach behaviour to understand the nature of cognitive incongruity and revise beliefs (Reisenzein, Horstmann & Schützwhol, 2019; Vogl, Pekrun, Murayama et al., 2019). Relatedly, fear differs from anger, another negatively valenced emotion concerned with goal blockage, misbehaviour or intentional mistreatment (Fisher, 2019). Anger is brought about by appraisals of certainty and individual (other) responsibility, motivating approach and engagement with the eliciting source as a way of retaliation, or to right the wrongdoing (Lazarus, 1991a; 1991c; Lerner & Keltner, 2001). Fear, on the other hand, involves appraisals of low certainty and typically situational responsibility and control (Lazarus, 1991c; Lerner & Keltner, 2001).

A closely related concept to fear is that of anxiety, so much so that some authors do not distinguish between fear and anxiety (e.g. Cacciotti & Hayton, 2015, Baumgartner, Pieters & Bagozzi, 2008; Kish-Gephart et al., 2009) whilst others choose to do so (e.g. Lazarus, 1991a; 1991c). According to Lazarus (1991c), fear and anxiety are elicited by different stimuli. Whereas fear is elicited by sudden and concern danger of physical harm, anxiety is elicited by appraisals of uncertain and existential threats. However, others have deemed it unnecessary to distinguish between the two, since they are both fundamentally ways in which the body naturally protects itself from harm or threats, whether they are potential or actual (Öhman, 2008; MacDonald, Kingbury & Shaw, 2005). As Cacciotti and Hayton (2015) point out, fear and anxiety share the same core theme: they are both negatively valenced emotions evoked from appraisals of threat in the environment that the individual(s) in question deem they are unable to control. Although there might be nuances in the psychophysiological reactions they trigger (Lazarus, 1991c; Öhman, 2008), it has been pointed out that the brain and behavioural mechanisms involved ultimately overlap (Barlow, 2000). Thus, the distinction between the experience of fear or anxiety is largely concerned with whether the threatening stimulus is imminent or prospective (Lader & Marks, 1973; American Psychological Association, 2000). Another related concept to fear

and anxiety is that of worry. According to Cacciotti and Hayton (2015), worry is concerned with challenges of daily adaptation rather than sources of existential threat, but can be understood as "an attempt to make existential anxiety concrete and external" (p.168) in order to manage and deal with it. Given that fear, anxiety and worry all share a common core meaning regarding threats or dangers to the self, in this thesis I follow a line of scholarship (e.g. Smith & Lazarus, 1990; Baumgartner, Pieters & Bagozzi, 2008; Cacciotti & Hayton, 2015; Cacciotti et al., 2016; 2020) and choose not to distinguish between fear, anxiety and worry. Instead, the negative emotional experience associated with dangers or threats in the environment – whether imminent and concrete or more existential and uncertain – are simply labelled and described as fear.

The evolutionary purpose of fear was to enhance the chances of survival and reproduction by alerting individuals to, and protecting them from, physiological and psychological threats or dangers that they perceived in their environment (Izard & Ackerman, 2008; Damasio & Carvalho, 2013). The experience of fear is therefore intended to enable adaptive responses, which are typically manifest as avoidance behaviours (Plutchik, 1980). In this way, scholars have argued that fear is avoidance-oriented and defined by the action tendency of withdrawal or avoidance, which serves to separate the individual from perceived aversive threats (Lazarus, Kanner & Folkman, 1980; Gray, 1987; Frijda, 1988). However, this is only a *tendency* rather than a universal action, and fear may protect individuals from threats through flight or withdrawal, freezing or avoidance behaviours (Roseman, Wiest & Swartz, 1994; Shaver, Schwartz, Kirson & O'Connor, 1987), or potentially by engaging with and attacking a threat in order to overcome it, if the individual deems they have the capacity to do so (Plutchik, 1990). What action fear ultimately motivates will depend on the nature of the threat and what is deemed to be helpful in terms of providing protection (Blanchard & Blanchard, 2008). In this respect, Frijda (1986) surmised that fear may lead to:

> "Carefulness when the threat is transitory; protective effort when there is no immediate way of escape or immediate need to escape; escape when such is possible, and the threat is more than protective behaviour can handle" (p.198)

The experience of fear triggers psychological and physiological adaptations in actors which are intended to raise their awareness of threats and allow them to respond quickly to protect themselves (Rolls, 1999). As mentioned previously, fear is typified by a motivation to withdraw or avoid a situation that is deemed physically or psychologically threatening, where an individual is deemed to have a limited influence on environmental outcomes (Plutchik, 1980; Roseman et al., 1984; Shaver et al., 1987; Lazarus, 1991a; 1991c; Lerner & Keltner, 2001; Ellsworth & Scherer, 2003). Physically, a fearful individual's pupils will dilate, allowing them to capture more information about their immediate environment, whilst their heart and respiratory rate may also increase in preparation for taking action, whether this be to run away, or perhaps to try and act on (e.g. fight) the feared threat (Damasio & Carvalho, 2013). Cognitively, fear can narrow an individual's perceptual and cognitive focus, to

identify and understand a perceived threat (Kish-Gephart et al., 2009), and promote short-term goals of survival over any longer-term goals (Baumeister, Vohs, Dewall & Zhang, 2007). For example, a fearful individual might push their friend into the path of an oncoming bear, to protect themselves, even if this would – in the long-term – damage their relationship with that person. Moreover, fear can make individuals more pessimistic in their judgements of risk and future outcomes (Lerner & Keltner, 2001; Schmidt-Daffy, 2015). Thus, fearful individuals are guided towards situations that are known and (presumably) safe from threat, and away from risky, uncertain and/or new situations where dangers or threats might reside (Clore et al., 1994). Fear is often activated automatically to allow individuals to process and deal with danger without necessarily being conscious they are doing so (Le Doux, 1996), which means that – sometimes – fear may not be consciously experienced until after it has been avoided. This post-event experience stimulates learning, and can create situation-specific understanding that, when activated again, trigger automatic fear responses based on prior experience (Walsh, 1995; Baumeister et al., 2007; Kish-Gephart et al., 2009).

2.3.4 Emotion: From individual to group-level

Although emotion is fundamentally an individual-level phenomenon, psychological research has also identified a number of mechanisms through which emotions may come to be experienced at a group-level (for reviews, see Barsade & Knight, 2015 and Menges & Kilduff, 2015). This has implications at both the individual and group-level (Barsade & Gibson, 2012), and consequently is relevant to contemporary organizations, who typically adopt differentiated structures and utilize team-based work to fulfil organizational tasks (Joseph & Gaba, 2020). With respect to the current state of the literature, the most well-studied aspect of group affect refers to convergence in individual experiences of mood and emotion (Barsade & Knight, 2015). However, there are also instances where groups may come to experience diverging affective experiences at any point in time as a consequence of a number of different mechanisms (Barsade & Gibson, 1998). In their review of the literature, Menges and Kilduff (2015) identified a multitude of different concepts that relate to group-level emotions[17], but this review will focus on the emotional responses and/or experiences of groups and will therefore be limited to two specific concepts and associated mechanisms relevant to this work: group-based and group-shared emotions (for distinction, see Table 2.6).

According to Menges and Kilduff (2015), g*roup-shared emotion* concerns emotions that members of a group collectively experienced during interactions with one another, and thus necessitates that individuals are in the presence of one another (physically or virtually) and have synchronised attention to the same eliciting stimulus, which is typically a condition of workgroups and teams in

[17] In their Academy of Management Annals article, Menges and Kilduff (2015) identify the following related concepts in the literature on group-level emotions: affective tone, group affect, group mood, group emotion, group-based emotion, shared emotion, collective emotion, emotional energy, emotional atmosphere, emotional climate, effervescence, and affective climate.

organizations (Barsade, 2002). This leads to similar appraisals being made, and generally convergence[18] in the emotions that group members come to experience. Similarly, Menges and Kilduff (2015) argued that group members may come to experience emotions without the presence of other group members, but based on their group membership. This asynchronous and non-interactive experience of emotion is known as *group-based emotion*, which occurs because group membership leads to individuals appraising a stimulus in a similar way, leading to (generally) converging emotional experiences. In this study, I conceptualized group-level emotion in the same way as previous strategy scholarship (e.g. Huy, 2011; Vuori & Huy, 2016), who had lent on the conceptualization of shared mental models (e.g. Mathieu et al., 2000), by defining it as instances where members of a group form similar appraisals and experience the same emotion. In this respect, I followed the recommendations offered by Kozlowksi and Klein (2000) for moving from micro to meso (i.e. individual to group) phenomena, identifying shared emotions where "individual data…revealed significant within-group agreement" (Kozlowski & Klein, 2000, p.216) in terms of the appraisals made and emotion experienced. Accordingly, how I conceptualized shared emotions differed from Menges and Kilduff (2015), who deemed that co-presence and attention to the same stimulus was necessary for what they termed 'group-shared emotions.' In this respect, shared emotions are defined here using a 'big tent' approach and encompass both what Menges and Kilduff (2015) deemed as 'group-shared' and 'group-based' emotions under one term, where co-presence to a stimulus is deemed largely irrelevant and the critical point being that individuals have made similar appraisal and experienced the same emotion.

[18] This is not a universal rule, though. Appraisal theorists have found that the subjective nature of cognitive appraisals means that the same stimulus can bring about distinct emotional responses amongst individuals (Smith & Ellsworth, 2003). In the context of groups, heterogeneity may emerge as a result of hierarchy, for example, which can alter how individuals perceive a given stimulus (Magee & Galinsky, 2008).

Table 2.6 - Differentiation between group-shared and group-based emotion

Menges & Kilduff (2015)		**This Study**
Group-shared emotion	**Group-based emotion**	**Shared emotion**
Group members are co-present, either physically or virtually.	Group members are not necessarily co-present with one another.	Group members may or may not be co-present
Group members are attending to the same stimulus in a synchronous manner.	Group members are not necessarily paying attention to the eliciting stimulus in a synchronous manner.	Group members may or may not be attending to the same stimulus in a synchronous manner
Emotions are experienced collectively, through synchronous attention to the eliciting stimulus, and interactions with other group members.	Emotions are experienced individually, as a consequence of group membership. This group membership means members form similar appraisals of a given stimulus.	Emotions are experienced individually, but the similar emotions are experienced throughout the group. There is therefore within-group agreement or homogeneity in terms of the emotion experienced, and the appraisal leading to this emotional experience.
e.g. A crowd at a concert experiencing mass excitement prior to an artist coming on stage.	*e.g. Emotions of individual Americans converging with compatriots on 4th July.*	*e.g. Members of R&D department experiencing fear of failing to meet organizational innovation goal*
Collective, synchronous, interactive experiences of emotion. Emotions are similar and shared.	**Individual, asynchronous, non-interactive experiences of emotion based on group membership. Emotions are similar, but not necessarily shared.**	**Members of the same group form similar appraisals and experience the same emotion. Emotions are similar but not necessarily experienced simultaneously**

The process through which group-level emotions come to emerge vary by discipline. Menges and Kilduff (2015) identified four key mechanisms in the extant literature, whereby emotions can come to be experienced by the group: inclination, interaction, institutionalization and identification. *Inclination* (Barsade et al., 2000; Arnaud & Schminke, 2012) is the least invoked of the four and refers to how the affective dispositions of group members lead to them experiencing emotions and moods of certain types. For example, those with high levels of positive affectivity are more likely to experience positive emotions like excitement. The extent to which the members of a given group hold similar affective dispositions means that they are more likely to experience similar emotions and demonstrate convergence in how the group feels. Research on small, medium and large groups supports this idea to the extent that members are typically selected through homophily rather than heterophily, and thus those with dissimilar affective profiles are unlikely to become members (Schneider, 1987).

Organizational behaviour and science scholars have generally explained the emergence of group emotions via *interaction* that occurs between individuals. The most well-known mechanism of interaction is emotional contagion (Hatfield, Cacioppo & Rapson, 1993; Barsade, 2002), where individuals 'catch' the emotions of others, leading to converging emotional experiences. Typically, contagion occurs through mimicry, where individuals copy the expressions of others, largely unconsciously (Hatfield, Carpenter & Rapson, 2014). It is also possible for individuals to consciously process others' emotions, Schachter and Singer (1962) reporting that people often consider how others feel when trying to establish how they ought to feel themselves. In particular, individuals seek to align their emotions with those of important others (Bartel & Saavedra, 2000), with group leaders supposedly being particularly contagious (Sy et al., 2013; Menges, Kilduff, Kern, & Bruch, 2014). Individuals may also suffer from empathic transmission, where the process of imagining being in the same situation can lead to similar emotional experiences (Maitlis, 2005). Interaction may also lead to similar emotional experiences through shared sensemaking, as groups come to a collective interpretation of events (Maitlis, 2005). Since group members tend to face similar events, they are liable to make similar interpretations or appraisals that subsequently lead to similar emotional experiences (George, 1996; Weiss & Cropanzano, 1996). However, as alluded to earlier, similar sensemaking does not necessarily equate to converging emotional experiences due to the subjective nature of the appraisal process (Huy, 1999; Smith & Ellsworth, 2003). Beyond small group settings, research has shown that individuals seek to share emotions through social sharing, which refers to "a description of the emotional event in a socially-shared language by the person who experienced it to another" (Rimé, 2009, p.65). Exposure to emotional narratives elicits emotions in the receiver (Lazarus et al., 1965), and thus if the primary elicitation of emotion leads to sharing, then this creates a loop leading to further secondary and tertiary social sharing (Rimé, 2009). The extent of this process of social sharing has been amplified further by the preponderance of computer-mediated communication (Guillory et al., 2011), which allows individuals who are not co-located to share their experiences through the use of social networking platforms like Facebook or Twitter, for example.

Sociologists have tended to explain the emergence of group-level emotions through processes of *institutionalization*. Individuals must act in accordance with the emotional norms, rituals and routines of the group, which determine what is the appropriate way to behave (Goffman, 1967). These norms are often prescribed by organizational management (Barsade & Knight, 2015) as a way of governing how members of a group act, leading towards convergence in the emotions that members display. Scholars have addressed these ideas under auspices such as emotional or affective culture (Barsade & O'Neill, 2014), social-cultural norms (Ekman & Friesen, 1975), emotional labour (Hochschild, 1983) and simply display rules (Rafaeli & Sutton, 1989; Ashforth & Humphrey, 1993). The existence of display rules are common in jobs that involve working with people, such as healthcare, education and hospitality (Brotheridge & Grandey, 2002), requiring members to express or suppress certain emotions.

For example, in the renowned work of John Van Maanen on Disney (Van Maanen & Kunda, 1989), employees were expected to demonstrate positive emotions in line with the claim of Disneyland being the "happiest place on earth" (Van Maanen, 1991, p.12). Similarly, in contexts like nursing, nurses may be expected to show positive emotions to comfort patients (Diefendorff et al. 2011). Generally, group members are educated about norms through display rules and socialization (Menges & Kilduff, 2015), and when they fail to adhere to or deliberately ignore the norms of a group, individuals tend to be subject to embarrassment or shamed by other members (Goffman, 1974). This forces individuals to suppress their discrepant emotions (Mann, 1999) as a way of fitting in with the group and restoring group norms, leading to convergence in displayed emotions. Despite convergence in the displayed emotions, sociologists often differentiate between on- and off-stage (or front- versus back-stage in Goffman's terminology [1974]), and thus convergence may be limited to on-stage settings, while emotions may in fact be divergent off-stage, leading to some authors to question whether or not this truly represents a shared emotion.

Evidence from psychology generally explains group-level emotions on the basis of *identification* with their group. Smith's (1993) intergroup emotion theory argues that when individuals see themselves in terms of their group membership, they come to experience emotions on behalf of the group. Taking inspiration from appraisal theories of emotion (Ellsworth & Scherer, 2003) as well as social identity and self-categorization theories (Tajfel & Turner, 1986; Turner, Hogg, Oakes, Reicher, & Wetherell, 1987), Smith suggests that individuals will interpret group-relevant stimuli and events in terms of what they mean for the group, rather than for them as an individual. They will also be aware of the prototypical emotions and feelings associated with that group. Together, these factors lead to group members exhibiting similar emotions. A complicating factor is that individuals tend to hold numerous group memberships at any one time (Hogg & Terry, 2000), meaning that what emotions they come to experience therefore depends on which memberships are 'active' at any one time. For example, Eury, Kreiner, Trevīno and Gioia (2018) work examining the Sandusky child abuse scandal at Penn State University highlighted how alumni exhibited a number of different emotional responses depending on the extent to which they identified as being an alum of Penn State.

2.3.5 Consequences of group-level emotions

Those who identify with a specific group who come to experience group-based emotions are generally motivated to engage with other members of the group and undertake collective action, particularly when they feel that their group has been disadvantaged (Van Zomeren, Spears, Fischer & Leach, 2004). The recent Black Lives Matter movements is a prominent example of how group-based emotions of various kinds can lead to collective action tendencies, where the black community – as well as members of other groups, some of whom have been responsible for their injustices – have protested and sought social change. In this manner, group-based anger has helped to galvanize change aimed at addressing inequalities, echoing previous findings in this domain (Leach et al., 2006). Individuals may

experience group-based guilt, stemming from the wrongdoing of their own group even when they have not been personally involved in the wrongdoing, leading to support for reparations (Brown & Čehajić, 2008; Brown, González, Zagefka, Manzi, & Čehajić, 2008; Imhoff, Bilewicz & Erb, 2012) and commitment towards apology (McGarty et al., 2005). Both the commitment towards apology and reparations through social change have been evident in the Black Lives Matter movements, as well as the Windrush scandal faced in the United Kingdom. Finally, group-based fear can lead to actions aimed at strengthening the group, something which is often evident when a group experiences threats around their identity. Wohl, Giguerè, Branscombe and Mcvicar (2011) found this to be the case when Canadians discovered that there was the possibility of a cross-national security agency with the USA, who felt a loss of sovereignty as a result. Similar behaviours have been observed and reported in the media in the ongoing Brexit negotiations in the UK.

Group-shared emotions affect how individuals participate in groups, and thus impact group composition as well (Menges & Kilduff, 2015). For example, George (1990) found that positive group affective tone was negatively correlated with absenteeism, whilst Bartel and Saavedra (2000) reported higher degrees of group membership stability when there was higher degrees of emotional convergence between members. Positive emotions have been found to facilitate cooperation in group environments (Barsade, 2002) and can also lead to the successful implementation of innovation and change (Huy, 2002; Choi et al. 2011), and therefore are related to group task performance. Research has also linked group-shared emotions to decision quality and creativity, with there being evidence that positive affect facilitates creativity in contexts when team members lack trust amongst one another (Williams, 2001; 2007; Tsai, Chi, Grandey, & Fung, 2012). Although there have been suggestions that diverging group emotions and moods can have a negative impact on group effectiveness (Barsade & Knight, 2015), divergence can deliver benefits, such as improving informational quality and mitigating the dangers of group-think in homogenously positive groups (Barsade & Gibson, 1998; Hareli & Rafaeli, 2008; Walter et al., 2013).

While Menges and Kilduff (2015) identify a plethora of studies on group emotion, they fundamentally argue that our understanding of how group emotion affects group functioning remains limited and demands further attention and empirical examination. This has been echoed by other scholars (Barsade & Knight, 2015; Vuori & Huy, 2016; In-Press), and led to calls for research using real-time and processual methods that may be able to trace capture what emotions are experienced, follow how they change over time, and (tentatively) link these changes with team-level/workplace outcomes (Barsade & Gibson, 2012; Barsade & Knight, 2015). Another limitation of the extant literature is its focus on small groups, and emphasis on microprocesses (Menges & Kilduff, 2015). Currently, there has been limited efforts to link these microprocesses to macro-level outcomes in terms of organization and industry performance and actions. As much of our understanding stems from psychology, where the modus operandi is largely quantitative methods and experimental studies, there

is a need for more qualitative processual research, which can help to elucidate phenomenon further and identify additional mechanisms at play. Finally, considering discrete emotions have distinct functions and behavioural consequences (Keltner & Haidt, 1999; Ellsworth & Scherer, 2003), there is also a need to move beyond the valence approach in the extant literature to consider and explore the consequences of discrete emotions experienced at the group-level.

2.4 Summary

The reviewed literature highlights a number of pertinent issues that exist within extant scholarship that require addressing. Scholars have been unequivocal in stating that the pursuit of novel technologies and innovation is critical for organizational survival and prosperity. At the same time, they have also established that incumbent organizations struggle to innovate and pursue particularly novel technologies and solutions, despite their great potential. Researchers seeking to explicate this puzzle have identified a number of structural and cognitive factors contributing towards incumbent inertia, but have given limited consideration to how middle and operational managers may communicate these opportunities to gain the attention and support of top managers and decision-makers. Our understanding of how these managers ought to communicate such opportunities is therefore limited. Similarly, there has been a tendency to privilege cognitive explanations of incumbent inertia without (fully) considering the role that emotion may play. Evidence from psychology suggests that this is problematic, having shown that there is a recursive relationship between cognition and emotion, surmising that the two ought to be considered in tandem if a holistic and behaviourally-plausible account is to be offered. In this manner, the current cognitive explanations of why incumbents struggle to innovate and pursue novelty are not fully developed and require further examination. Accordingly, this thesis seeks to address these limitations in our understanding by answering the two following research questions:

(1) *How do managers communicate novel technological opportunities in incumbent organizations, in order to gain the attention and support of key organizational decision-makers?*
(2) *How does emotion affect the pursuit of novel technological opportunities in incumbent organizations?*

In addressing these research questions, this thesis responds to calls from innovation scholars to provide more behaviourally plausible accounts of the innovation process (Gavetti, Levinthal & Ocasio, 2007; Hodgkinson & Healey, 2011; Gavetti et al., 2012; Vuori & Huy,2016; Healey & Hodgkinson, 2017; Raffaelli, Glynn & Tushman, 2019) by explaining what emotions managers come to experience in the pursuit of novel technological opportunities, and how these affect their cognitions and subsequent actions and decisions. In this respect, this thesis also responds to calls from both innovation and psychology scholars to further examine and explain how emotion affects group functioning using process approaches (Barsade & Knight, 2015; Menges & Kilduff, 2015; Vuori & Huy, 2016; In-Press). Finally, this research addresses calls for further investigation of the political aspect of communication

in contemporary organizations, and how this can affect the subsequent decisions and actions that organizations take (Ocasio, Laamanen & Vaara, 2018).

3 Methodology

The first two chapters of this thesis identified the research questions and provided an overall picture of the conceptual framing and expected contributions of this research. In this chapter, I will provide an overview of the methodological approach employed in this study, beginning with a discussion of the ontological and epistemological assumptions on which this study was based (Section 3.1), before moving on to discuss why grounded theory was selected as the research strategy for this thesis (Section 3.2). In Section 3.2, the alternative strands of grounded theory that can be drawn upon are considered, and a justification provided for the use of Straussian grounded theory in particular. In Section 3.3, I explain how my philosophical assumptions, chosen research strategy and approach to data collection used in this study correspond, and provide a justification for their combination. In Section 3.4, I introduce the research setting and provide contextual information regarding the background of the studied case. In Section 3.5, I describe the data collection techniques utilized in this study. In Section 3.6, I address the ethical considerations and approval sought to carry out this study, whilst in Section 3.7, the data management techniques that were utilized in the process of this research are considered. Finally, Section 3.8 describes the analysis process I engaged in, explaining the different analytical stages and techniques used in the study.

3.1 Ontological and Epistemological Assumptions

An important consideration of any research is the philosophical orientation from which the work is conducted. Such assumptions will inform how information is both gathered and interpreted throughout the research process (Lawson, 1997; Crotty, 1998; Buchanan & Bryman, 2007), ensuring that the best possible insight is provided for that version of reality (Fleetwood, 2014).

This study is ontologically and epistemologically grounded in Roy Bhaskar's (1975) critical realism. Bhaskar's (1975) version of critical realism is positioned in the middle ground between the poles of interpretivism and positivism (Danermark et al., 2002; Healey & Hodgkinson, 2014), asserting an objective (realist) ontology, along with a subjective (relativist) epistemology (see Table 3.1 for overview and comparison of different philosophical orientations). In doing so, critical realists believe that reality exists 'out there' independent of the individual and our knowledge of it, however, our knowledge of reality is always mediated and subjective, shaped by our unique lived experiences (Danermark et al., 2002; Fleetwood, 2005). Observations of the world are therefore always theory-laden, meaning that it is difficult to achieve a truly objective and value-free account of the world. Accordingly, while "a critical realist perspective affirms the possibility of truthful knowing, [it] acknowledges that human limitations undermine claims to indubitable or objective knowledge" (Miller & Tsang, 2011, p.144). The initial appearances and explanations of phenomenon can be misleading, meaning that new explanations may emerge over the course of time (Collier, 1994). As such, the fallibility of knowledge claims about the world is emphasised by critical realists.

Bhaskar (1975) also argued that reality is stratified, consisting of three distinct strata: the real, the actual, and the empirical. The real is where generative mechanisms with causal powers that have the capacity to produce events reside. The actual is where observed events or patterns of events occur, either naturally or through controlled conditions. Finally, the empirical is where experiences of events occur. These three levels are related to one another, but cannot be reduced to nor explained solely in terms of the layer beneath (Elder-Vass, 2010). In this respect, Bhaskar (1975) also made a distinction between the intransitive and transitive objects of knowledge, which Healey and Hodgkinson explained as:

> "The intransitive objects of knowledge…exist independently from human conception (e.g. light, mercury, neurons and so on) [while] the transitive objects of knowledge produced through such conception…are facts, theories, paradigms, models and the like" (2014, p.771).

While only events that occur in the empirical are observable and experienced, critical realist researchers seek to provide explanations for these events in terms of the underlying structures and mechanisms that cause them to occur. The identification of features of the actual and real takes place through a process called retroduction. Retroduction is an inferential reasoning process through which researchers try and reconstruct the conditions necessary for a given social phenomenon to occur, in terms of the generative mechanisms and structures involved (Danermark et al., 2002). In other words, working backwards from a given event or experience, critical realist researchers consider what must be true of the world for this event to have happened in the first place.

In acknowledging the fallibility of knowledge and claims about the world, critical realist researchers are reflexive and accept that some accounts of reality may be more proximate than others. To enhance the proximity of claims about reality, critical realists generally endorse triangulation across data sources and methods, as a means of arriving at the most proximate account of reality; multiple methods and data sources are encouraged because critical realists believe that different sources help illuminate different aspects of reality (Hodgkinson & Rousseau, 2009).

The progression of science, according to critical realists, therefore, occurs through critiques of the explanatory value of proposed theories and accounts, rather than a linear progression towards 'the truth' (Healey & Hodgkinson, 2014). Such inquiry is fundamentally driven by a logic of emancipation (Archer et al., 1998), highlighting critical realism's links to Marxism. In the process of unearthing and developing an understanding of social structures and their constraining and/or oppressive effects, transformative action becomes possible (Collier, 1994; Kilduff, Mehra & Duff, 2011). While Marxism sought to understand the constraining and oppressive structures faced by man as a means of transforming them to "foster a democratic society and critical citizenry" (Foley, 2002, p.472), emancipation in the context of management research is more about understanding situations and being able to act upon them; for example, the ability to address the status quo, enabling new ways of thinking

and doing (Hodgkinson & Starkey, 2012). With respect to this thesis, the aim of understanding the role that emotion plays in the pursuit of novel technological opportunities in incumbent organizations was driven by an intention of better understanding constraining structures and mechanism in this process. Generating knowledge and insight could therefore allow suggestions to be made as to how such impediments might be reduced or removed, thereby facilitating the emergence of novel technologies in established organizations.

Table 3.1 - Comparison of different philosophical orientations, adapted from Saunders, Lewis & Thornhill (2009)

	Critical Realism	**Positivism**	**Interpretivism**
Ontological position	*Realist*	*Realist*	*Relativist*
	One true reality exists 'out there' independent of human knowledge of it Reality is stratified into three layers (the empirical, actual and real)	One true reality exists 'out there' independent of human knowledge of it Reality is undifferentiated (only empirical exists)	Multiple realities exist, socially constructed within the minds of individuals
Epistemological position	*Relativist*	*Realist*	*Relativist*
	Our knowledge of the world is always conceptually mediated, based on our perspectives and unique experiences.	Credible and meaningful data is only what is directly observable and measurable	All people experience different social realities; all of these different interpretations are valuable
Aims of inquiry	Seeks to explain experiences in terms of underlying causal mechanisms	Attempts to uncover universal laws that provide causal explanations and allow prediction	Reveal new understandings and worldviews
Methods for inquiry	*Retroductive*	*Deductive*	*Inductive*
	Both qualitative and quantitative methods can be used to help reveal different aspects of reality	Typically, quantitative analysis using large sample sizes	Small samples that use qualitative methods to allow for in-depth exploration

3.2 Research Strategy

In this research, I utilized Straussian grounded theory (Strauss & Corbin, 1998) as my research strategy. The decision to use grounded theory was based on the fact that I sought to address a poorly understood phenomenon, and to elaborate on and build theory regarding how large, established organizations are able to overcome the challenge of their incumbency to pursue novel technological opportunities (see Table 3.2 for an overview of alternative research strategies). Although scholars have examined and explained why incumbent organizations may struggle to innovate and pursue forms of novelty (e.g. Tripsas & Gavetti, 2000; Gilbert, 2005; Benner & Tripsas, 2012; Kaplan & Eggers, 2013; Vuori & Huy, 2016; Raffaelli, Glynn & Tushman, 2019), there has been considerably less attention given to why some incumbents *are* able to achieve this outcome, leaving us with limited understanding of this phenomenon. Poorly understood phenomena are best explored using qualitative methods (van Maanen, 1979; Corbin & Strauss, 2015) because they are effective at generating insights that can explain how and why the phenomena occurred. Relatedly, grounded theory is an effective way to build or extend theory through the systematic analysis of qualitative data (Strauss & Corbin, 1998; O'Reilly et al., 2012), especially textual materials (i.e. interviews and observations [La Rossa, 2005]) which can be a basis for explaining 'how' and 'why' phenomenon might occur. As such, grounded theory is an appropriate strategy for tasks of theoretical elaboration and development (Eisenhardt & Graebner, 2007). Additionally, grounded theory affords flexibility in one's research strategy, permitting the researcher(s) to respond to emergent themes in the data in order to provide accounts that closely resemble the lived experiences of participants and by extension, the phenomenon (Fendt & Sachs, 2008; Corley, 2015). This meant that while I focused on how established organizations utilize business ecosystems to overcome the challenge of their incumbency during the nascent stages of my research, I was able to direct my attention to the emerging trends within my data. Accordingly, my research took on a number of distinct phases and focuses, ultimately focusing on and explaining the role that emotion plays in this process since this was the salient theme within my data.

3.2.1 Grounded Theory

Grounded theory was first proposed by Glaser and Strauss (1967) in reaction to the extremely positivistic approaches that were being used in the majority of social science research (O'Reilly et al., 2012). Glaser and Strauss rejected the application of natural scientific methods to study social life, instead proposing their qualitative method for developing theory about the interpretative realities of actors through the systematic collection and analysis of data (Suddaby, 2006). Using this method, theory could directly emerge from the empirical data that was collected (Belfrage & Hauf, 2017). A grounded approach is defined by two distinguishing features: the constant comparison of data collected and analysed, and a theoretical sampling strategy.

3.2.1.1 Constant Comparison

Grounded theorists engage in a constant comparative process as they iterate between the data they collect and that which they already have, to help them to refine their insights and build an explanation regarding the phenomenon. Comparisons happen on various levels, as new codes are compared with existing codes; codes with categories; categories with other categories, and ultimately the emerging theory with existing theory (Glaser & Holton, 2004). Looking for (dis)confirming instances within the emerging pool of data helps the researcher to understand what is (or is not) understood and ultimately guides inquiry until an adequate explanation can be offered. This is an ongoing process that occurs at all stages of coding (open, axial, selective), right until a grounded theory is created (Langley & Abdallah, 2011). Facilitating these comparisons are theoretical memos: as researchers engage in data collection and analysis, they are encouraged to write down their developing insights and ongoing reflections in memo form, which they can then refer back to as a guiding light throughout the research process (Heath & Cowley, 2004).

3.2.1.2 Theoretical Sampling

Grounded theorists aim to develop or extend rather than test theory, and thus select cases which help them achieve this task in an endeavour known as 'theoretical sampling' (Eisenhardt & Graebner, 2007). By selecting cases based on their ability to help the researcher better understand the emerging data categories, denser and more nuanced theoretical explanations can be offered, which account for the phenomenon's patterns and variations (Corbin & Strauss, 1990; Eisenhardt et al., 2016). Theoretical sampling continues until the researcher arrives at theoretical saturation, when collecting new data provides no new insights, and the point at which the phenomenon has been adequately explained (Glaser & Strauss, 1967; Strauss & Corbin, 1998). The tradition of theoretical sampling means that grounded theory is an emergent research strategy, in that it isn't possible to predetermine the entire data collection (Glaser & Strauss, 1967). Rather, the research is guided by the emergent data trends, as analysis reveals where more data is needed.

3.2.1.3 Strands of Grounded Theory: Classical, Straussian, Constructivist

Since its inception in 1967, a number of iterations of grounded theory have emerged, which all treat the research process slightly differently (Bryant, 2017). Despite their divergence (see Table 3.3 for a comparison), all approaches are still forms of qualitative inquiry where the motivation is the discovery of theory from systematic data collection and analysis, as was initially proposed by Glaser and Strauss (Eisenhardt et al., 2016; Timonen et al., 2018).

Table 3.2 - Evaluation of alternative research strategies

	Narrative Approach	**Phenomenology**	**Ethnography**	**Grounded Theory**	**My Research**
Key Work	Polkinghorne (1995) Czarniawska (2004)	Husserl (1970) Sanders (1982)	Van Maanen (1979)	Glaser & Strauss (1967) Strauss & Corbin (1998) Charmaz (2008)	Strauss & Corbin (1998)
Aim	Explain the meanings and experiences of a single individual	Understand the lived experience of a particular phenomenon	Study and description of a specific culture	To develop an explanatory theory that emerges directly from the data, of a problem that is poorly understood	*To build on existing and develop theory which explains how emotion affects the pursuit of novel technological opportunities in incumbent organizations*
Sources of Data	Interviews	Observations of the lived experience, and interviews	Observations and interviews. Some document analysis	Observations, interviews, and document analysis	*Observations, interviews, and document analysis*
Sampling	Participants have experienced the phenomenon of interest	Participants have experienced the phenomenon of interest	Participants are members of the studied culture	Participants have experienced phenomenon under various conditions	*Participants must be involved in the pursuit of novel technology at an incumbent organization*
Reasons for (not) using	Focuses on individual experiences & meaning. Unlikely to be suitable for explaining how multi-actor processes like innovation occur.	Would provide insight into the experience of pursuing novel technological opportunities but would be unable to help explain how this process occurs, so would not help achieve the research aim.	Ethnographic studies aim to provide a description of a given culture, which is not the aim of this research.	Suitable for developing new/elaborating existing theory through the systematic analysis of data, to help answer questions that extant theory cannot adequately address.	*Grounded theory the most appropriate strategy to meet the aims of the research. However, I also incorporated aspects of ethnography to collect data, to support my grounded research strategy*

Table 3.3 - Comparison of different strands of Grounded Theory

	Classical	**Straussian**	**Constructivist**
Philosophy	Positivist	Symbolic Interactionist	Constructivist
Research Approach	Inductive	Abductive	Inductive
Analytical Process	*Substantive Coding*: Open line-by-line codes, followed by Selective coding that explicates a core category and those that relate to it. *Theoretical Coding*: conceptualization of inter-relationships between concepts.	*Open coding* to identify the properties & dimensions of each category. *Axial coding* that establishes the links between each category and its sub-categories. *Selective coding* to integrate the categories using an identified 'core category.'	*Open coding* to capture what the principal concerns of participants are, and how they resolve these concerns. *Refocused coding* of recurring codes, or of codes that seem critical to explaining the phenomenon, which are elevated to be 'theoretical categories' and selectively coded using theoretical sampling.
Aim	To *discover* a grounded theory that emerges from the data	To *create* a grounded theory through systematic analysis of data	To *construct* a grounded theory of the phenomenon according to the experiences of research participants
Key Readings	Glaser & Strauss (1967) Glaser & Holton (2004) Holton (2010)	Strauss & Corbin (1998)	Charmaz (2000)

3.2.1.4 Rationale for choosing Straussian Grounded Theory

A Straussian grounded approach was considered to be the most appropriate form of grounded theory for a number of reasons. Primarily, scholars have been clear that ontological and epistemological assumptions should inform the methodology adopted to ensure that the method can best capture that version of reality (Lawson, 1997; Fleetwood, 2014). While Straussian grounded theory is symbolic interactionist by background, it was compatible with other perspectives. Vitally, Strauss and Corbin asserted the existence of a realist ontology and relativist epistemology by claiming that "only God" could understand "the real nature of reality" (Strauss & Corbin, 1998, p.4), and that the purpose of social scientific inquiry was to move towards an improved representation of reality. For this reason, Kenny and Fourie argued that Straussian grounded theory "unambiguously expounded a post-positivist critical realist ontology" (2015, p.1282). Given this apparent coherence between my ontological and epistemological assumptions as a researcher and the Straussian grounded approach I proposed to take, making it an appropriate research strategy for me to utilize in my endeavour to build theory around the realities of incumbent innovation.

Although Classical grounded theory suggests ignoring the literature until after data collection and analysis has been completed (Glaser & Holton, 2004), Straussian grounded theory encourages using the literature as a guiding framework for investigation, which can be updated according to emerging themes within the data (Corbin & Strauss, 1990; Strauss & Corbin, 1998; Emmel, 2013). Given this research is being conducted as part of a doctorate degree and thus the research process is a new experience, this was deemed to be a valuable asset in ensuring that the research remained focused and advanced in a timely manner (Gehman et al., 2017). Furthermore, the notion of the academic researcher as a 'blank canvas' (Timonen et al., 2018) is increasingly refuted by scholars, who acknowledge that researchers bring worldviews and assumptions based on prior experience into the research process (see Gioia, Corley & Hamilton, 2013). In this respect, it seemed more logical to follow an approach that embraces prior knowledge and understanding rather than seeks to suppress it.

Another rationale for using a Straussian approach was the detailed analytical guidelines offered by Strauss and Corbin (1998). At the outset of this research, these were considered to be a useful tool that could help guide what can potentially be an otherwise overwhelming coding process. Despite heavy criticism for being overly formulaic (see Glaser, 1992; Charmaz, 2000), more recent readings have emphasised that they are guiding frameworks rather than steadfast rules (Corbin & Strauss, 2008). Corbin has herself stated that these "Techniques and procedures are tools to be used by the researcher as he or she sees fit to solve methodological problems. They are not a set of directives to be rigidly adhered to" (Corbin in Morse et al., 2016, p.40). For this reason, Straussian grounded theory and its detailed procedures were seen as a beneficial 'zimmer-frame' for the researcher to refer back to as necessary, to help with and guide the data collection and analysis procedures, particularly during the earlier stages of analysis[19].

Finally, the Straussian approach was felt to better support the aims of this research than either the Classical or Constructivist approach, as the aim was to explain a phenomenon that is not adequately explained in the existing literature. Straussian grounded theory encourages an abductive approach in which the researcher iterates between phases of inductive and deductive investigation in order to develop new insights. Motivated by a surprising fact or puzzle, researchers engage in phases of induction to collect and analyse data about the puzzle and form explanatory hypotheses, searching the extant literature for existing explanations (Mantere & Ketokivi, 2013). They then proceed to test these hypotheses in phases of deduction. Straussian grounded theorists repeat this cycle as they improve and

[19] I would like to note that while the analytical guidance provided by Strauss and Corbin (1998) was a reason why I initially adopted Straussian grounded theory, as the research(er) developed and I began analysing my data, I increasingly found this guidance constraining. Accordingly, my analysis process more closely resembled the one described by Gioia, Corley and Hamilton (2013). I found that their guidance allowed me to elucidate on the phenomenon and make adequate progress. In the words of Eisenhardt, Graebner and Sonenshein (2016), it afforded "rigor without rigor mortis" (p.1119). A more detailed explanation around this will be provided in Section 3.5.4.

refine their explanations (Heath & Cowley, 2004; Suddaby, 2006; Tavory & Timmermans, 2019). Conversely, Classical grounded theory encourages a purely inductive approach, making it difficult to provide these sorts of explanations (Glaser & Holton, 2004; Gehman et al., 2017), which is also the case with a Constructivist grounded approach.

3.3 Explaining my research approach: Why combine critical realism, Straussian grounded theory, and ethnographic data collection techniques?

The combination of a critical realist philosophy, Straussian grounded theory research strategy, and ethnographic data collection techniques was deemed an appropriate way to address the aims of this research, given the natural complementarities that exist amongst critical realism, grounded theory and ethnography (see Figures 3.1 and 3.2 for visual representations of how they are combined and relate to one another). As discussed in Section 3.2.1.4, the Straussian grounded research strategy utilized in this research is compatible with a critical realist perspective, given that Strauss and Corbin (1998) asserted the existence of an external and objective reality that researchers could explore and uncover, but only in a limited manner (i.e. they emphasized a realist ontology and relativist epistemology, as well as the fallibility of knowledge). The purpose of research, according to Strauss and Corbin, was therefore to move towards an improved representation of reality (Kenny & Fourie, 2015). In other words, to try and capture the intransitive domain of knowledge as closely as possible in the transitive domain of knowledge. Additionally, critical realism endorses a retroductive analytical process, whereby researchers seek to explain the observations they make in the empirical by identifying the structures and mechanisms in the actual and the real which must be necessary for a given social phenomenon to occur (Sayer, 1992; Rees & Gatenby, 2014). The abductive analytical approach used by Straussian grounded theorists is a way in which this retroductive process can be facilitated. By iterating between phases of induction and deduction, Straussian grounded theory seeks to develop potential explanations of a given phenomenon, in conjunction with the extant literature. Possible explanations in terms of key mechanisms and structures can therefore be derived inductively, before being further tested deductively through the collection of additional data and use of the constant comparison technique, to assess the veracity of provisional explanations. This process can continue until researchers arrive at a robust explanation where additional data collection does not provide new insight (i.e. theoretical saturation), and an explanation in terms of key concepts (mechanisms and structures) is generated, which generalizes beyond the immediate circumstances (Gioia, Corley & Hamilton, 2013). The specification of essential and general conditions and concepts that underpin a given social phenomenon that generalize beyond the given context is not only a key tenet of grounded theory, but also an aim of critical realist research (Strauss & Corbin, 1998; Miller & Tsang, 2011).

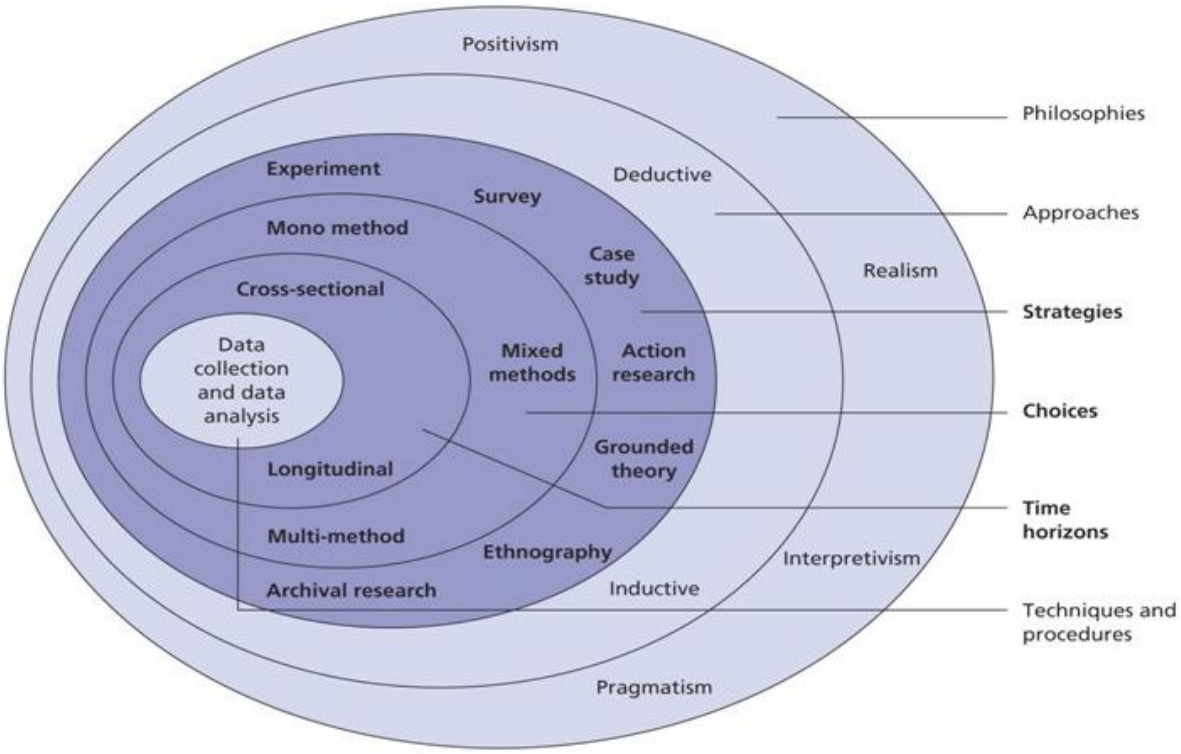
The combination of critical realism and ethnographic data collection techniques is also apt, given assertions that critical realism is an effective underlabourer for ethnography (Rees & Gatenby,

2014). Similarly, Kilduff, Mehra and Dunn have argued that critical realism is "best investigated through ethnographic and historical research" (2011, p.308). An ethnographic approach to data collection is appropriate for critical realist research because by getting inside the heads of participants in order to understand their subjective experiences, critical realist researchers can begin to access and understand the empirical domain of reality, following which efforts can be made to link such experiences to social structures and identify the generative mechanisms involved in the phenomenon, providing an explanatory account in the process (Reed, 2005). Similarly, critical realism can help to develop ethnographic explanations, which describe a given culture (Van Maanen, 2011; Watson, 2011) but fail to explain *why* these conditions are reproduced or transformed. Porter (2002) draws attention to the lack of attention shown to social structures in ethnography generally, as a consequence of the influence of Schultz and phenomenology. The stratified ontology assumed by critical realists (Bhaskar, 1975), however, means the purpose of inquiry is to go past the observable and to identify the unobservable structures and mechanisms that are responsible for the occurrence of social phenomenon (Collier, 1994). In this respect, critical realism can help advance descriptive ethnographic accounts by reintroducing the role of structures (Rees & Gatenby, 2014), which is central to the philosophy's emancipatory doctrine: by understanding the structures that constrain action, actors can address them and seek to reproduce or transform them as necessary (Archer et al., 1998; Trigg, 2001). In this respect, my choice to combine critical realism and ethnography follows the likes of Porter (1993), Banfield (2003), Miller and Tsang (2011) and Barron (2013), who have combined or encouraged the use of critical ethnography in fields including nursing, education, strategy and innovation.

Finally, combining Straussian grounded theory and ethnographic data collection techniques was also appropriate for my aims of theoretical development and elaboration, given the complementarities between the two. To avoid confusion: I adopted a grounded theory research strategy (i.e the overarching research process adhered to and was guided by the principles provided by Strauss and Corbin [1998]), whilst approaching my data collection the way that ethnographers (see van Maanen, 2011) collect data (for visual distinction, please refer to Figures 2 & 3). In other words, the data collection process involved extensive fieldwork where I was in close proximity to the participants of interest for extended periods, observing and interviewing them, in order to develop an intricate understanding of their lived experiences, and the everyday realities involved in trying to commercialize novel technologies (Watson, 2011; van Maanen, 2011). Specifically, my data collection efforts emphasised observations, interviews and conversations with participants, as well as document analysis, which are seen as the key tools for ethnographers. However, my study was not an ethnography per se, because I did not seek to provide a descriptive account of a culture (cf. van Maanen, 2011). The prolonged engagement encouraged by ethnographers breeds high levels of familiarity and trust with participants, which encourages them to be familiar and candid in their insights (Van de Ven & Johnson, 2006). This enhances the quality of data that can be collected and subsequently analysed, in accordance with grounded theory principles,

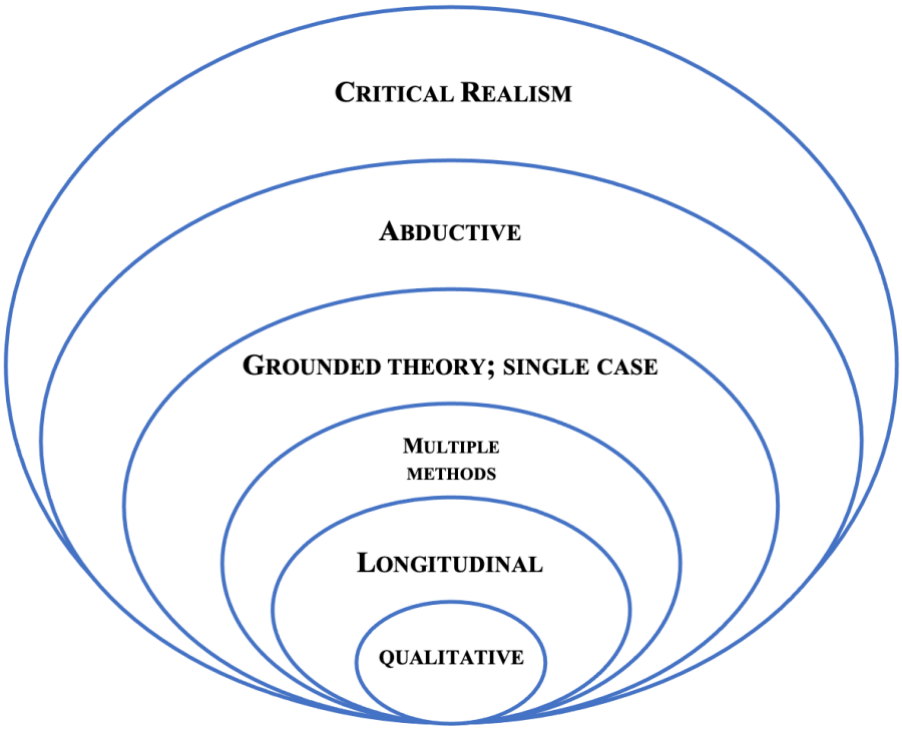
to develop a better understanding and theory about a poorly understood phenomenon. In my own study, an additional benefit of this familiarity was that when the focus of my research shifted[20] to look more specifically at how the cognitions and emotions of groups of managers in the organization affected the innovation process, the rapport I had developed allowed me to have honest and insightful conversations with participants related to these specific areas. More pertinently, prolonged study of this kind affords an in-depth understanding of the lived experiences of participants and the taken-for-granted realities of the population as they go about their everyday life to be developed. This enabled me to understand 'how things worked' (Watson, 2011) and to identify critical structures, mechanisms and key relationships that could help explain how and why the phenomenon occurred (Easterby-Smith et al., 2015; Cornelissen, 2017). In doing so, ethnographic data collection helped me to develop a theory which was grounded in and emerged from the systematic analysis of qualitative empirical data, following in the footsteps of other scholars in the field of innovation and strategy who have successfully combined grounded theory and ethnography for the purpose of theoretical development and elaboration (e.g. Kaplan, 2008; Kellogg, 2009; 2012; Smets et al., 2015).

Figure 3.1 - 'Research Onion' from Saunders (2009)



[20] This shift is detailed and discussed in Chapter 3, Section 3.5.

Figure 3.2 – Research design of this thesis depicted using 'Research Onion' from Saunders (2009)



3.4 Research Setting

I studied the pursuit of a novel technological opportunity at TechCorp (pseudonym), a major multi-technology incumbent. With origins dating back to the mid-19th Century, TechCorp has grown into one of the largest technology organizations in the world, operating in the communications field in almost 200 countries worldwide. They employ over 100,000 around the globe, and report an annual turnover exceeding $35 billion (TechCorp Annual Report, 2020). TechCorp have established market-leading positions in various technological domains and have been the source of a number of breakthroughs in communications technology. As such, TechCorp has a reputation for being an innovative, trusted and reliable supplier of technology and solutions, a reputation that is highly valued and maintained at all opportunities.

My access to TechCorp was initially facilitated by my secondary supervisor on the basis of a previous research project and pre-existing relationship with managers at TechCorp. Managers at TechCorp were keen to have an objective set of eyes to offer feedback on how they carried out innovation, and in fact initially proposed the idea of a PhD examining the efforts to commercialize QKD. A meeting was held between managers from TechCorp, the researcher and supervisory team to discuss the proposed parameters of my research, in terms of what data and access I required or expected, as well as to outline the expectations of TechCorp. My access required a Non-Disclosure Agreement

(NDA) to be signed between TechCorp and Durham University, given I would be privy to confidential company information. As part of this agreement, I was given an industrial supervisor who oversaw the project I would be studying, and who could help facilitate my initial access to individuals and meetings relevant to my research. On the basis of developing an excellent relationship and rapport with not only my industrial supervisor, but also their immediate team and close acquaintances, my access to TechCorp was unfettered.

At TechCorp, I specifically focused on their attempts to commercialize quantum key distribution (QKD) technology. QKD is an innovative method of key distribution technology, in which secret keys can be distributed between one point and another, encrypted in particles of lights called photons. Any attempts to intercept these keys will alter the physical state of these photons, meaning that QKD is a tamper-proof and totally secure method of communication. Should there be an attempt to access or hack the key, the users will be aware of these efforts, allowing them to dispose of the key and begin the process again, thus guaranteeing the sanctity of their communication.

As QKD is based upon the principles of quantum physics rather than classical mathematics, QKD represents a radical departure from TechCorp's existing methods of providing encryption and secure communication. However, their existing methods of providing encryption are under threat due to global developments being made towards large-scale quantum computers. Quantum computers possess remarkable processing capabilities and are particularly adept at adept at solving complex mathematical problems. This promises radical improvements in tasks such as modelling chemical compounds and solving operational problems, but it also constitutes a threat to existing forms of encryption, which are based on large integer factorisation problems. Although quantum computers have not quite achieved quantum supremacy, it is believed to be a matter of time before they do so, which means that all forms of communication in their current form are susceptible to being hacked. Given global trends towards increasing interconnectivity and the reliance of many economies on securely transmitted data, there is a significant need for alternative and quantum-safe methods of encryption and communication in order to mitigate this threat. In the UK alone, transport systems could be compromised, bringing the nation to an inadvertent halt.

Aware of the threats posed by quantum computing, and the potentially catastrophic scenarios that could arise, TechCorp's have explored alternative methods of encryption that can mitigate the threat. An inability to provide secure communication capabilities to their customers would undoubtedly damage their revenue streams, whilst TechCorp's reputation for being a reliable and trustworthy provider of security products and services would be brought into question. As a multi-technology incumbent in a highly contested marketplace, failure to address this threat would likely result in a loss of market position to their competitors. In light of these factors, the R&D department at TechCorp have engaged extensively with QKD and consider it to be an appropriate solution that is able to address the quantum computing threat. Considerable effort has therefore been put into trying to commercialize

QKD, making it a theoretically relevant case to examine (Eisenhardt, 1989a; Siggelkow, 2007) to help understand the nuances of incumbent innovation.

3.5 Data Collection

I conducted a single, in-depth case study of QKD at TechCorp, where I was embedded in the field for the duration of my study. This period lasted 24 months from start to finish (September 2018 to August 2020). While the use of multiple case studies has been popularised by Kathleen Eisenhardt (1989a), the use of single case studies provides scholars with a unique opportunity "to see new theoretical relationships and question old ones" (Dyer and Wilkins, 1991 p. 614). Single case studies are therefore "particularly capable of providing unprecedented insights into…nascent domain[s]" (Savaget, Chiarini & Evans, 2019, p.369), making it an appropriate way in which to build theory, in this instance regarding the role of emotion in the pursuit of novel technological opportunities within incumbent organizations. Historically, some of the most seminal examples of theory-building work in the domain of innovation have been single case studies, such as Burgelman's (1983) study of the internal corporate venturing process at IBM, Tripsas and Gavetti's (2000) single case examining the failure of Polaroid, and Vuori and Huy's (2016 & In-Press) in-depth case studies of the innovation and strategy processes at Nokia.

One of the major benefits of single cases is their revelatory power (Ozcan, Han & Graebner, 2017), which typically stems from receiving a degree of access that is not usually granted to outsiders, allowing rich data to be collected over prolonged periods of time. Given that the pursuit of novel technological opportunities is inherently processual, it was important for me to collect data over a period of time in order to capture and explain the associated temporal dynamics of this process (Langley, 1999). Innovation is also innately social, and thus it is important to study social interactions and dynamics for prolonged periods, to see how they emerge and develop, in order to provide a holistic and encompassing account. My unfettered access to TechCorp combined with these needs meant that studying and collecting data from one context was more appropriate than trying to cover and compare multiple contexts. In this manner, conducting a single case study allowed me to better carry out in-depth, longitudinal research that I would not have been able to replicate across multiple cases given time and resource constraints. Furthermore, by focusing on a single case, I was able to forge stronger connections and rapports with my participants, resulting in richer and more candid insights that allowed me to truly explain the phenomenon of interest, closely capturing the participants' point of view. This rapport allowed me to gain access to meetings I otherwise would not have been able to attend, permitted my involvement in highly confidential conversations, allowed me to see presentations due to be given to the board ahead of time (and given debriefs on how they went) and receive honest 'warts and all' accounts and opinions on matters. These factors meant that the richness of my data far exceeded what could have been expected otherwise, or what would have been possible with a number of cases.

As the puzzle which I entered the field with was to understand how incumbent organizations commercialize particularly novel and complex technologies, my research demanded the collection of qualitative data. To do this, I used ethnographic data collection techniques (e.g. van Maanen, 1989; Kaplan, 2008; Kellogg, 2012) which sought to reveal and explain how innovation takes place at large, established organizations. Ethnography involves the study of culture (van Maanen, 1979), and therefore researchers immerse themselves in close proximity to their participants for prolonged periods of time in order to develop a granular understanding of their lives and "how things work" (van Maanen, 2011, p.220). In studying culture, ethnographers come to appreciate the meanings and practices of the studied population, and how these are produced, sustained and altered through interactions in that context (van Maanen, 1988). Ethnographers become attuned to the nature of day-to-day practices, patterns of interaction and ways of working (Eisenhardt, Graebner & Sonenshein, 2016) and are well-set to capture the subtle and non-verbal. Ethnographies are therefore able to account for what people cannot, or will not, share (Langley & Abdallah, 2011; Bechky, 2011). As such, an ethnographic approach to data collection was considered to be an effective way for comprehending and capturing the everyday realities (Zilber, 2002) associated with innovation and the pursuit of novel technology at TechCorp, and a means to begin understanding the key structures and mechanisms involved in this process. An overview and description of data collected and how it was used is available in Table 3.4.

3.5.1 Sampling strategy

Initially, my sampling strategy was purposive (Patton, 1990), as I aimed to become familiar with the QKD project and to develop a broad understanding of how innovation took place at TechCorp. I therefore sought to speak to those familiar with QKD and the innovation process broadly, as well as analyse documents and attend events which could be insightful in this respect, a process which was facilitated with help from my industrial supervisor. Subsequent interviews and events worth observing were identified using snowball sampling, with numerous participants recommending colleagues or individuals who were relevant or could be useful to my research.

After my early data collection and analysis efforts generated some initial emergent themes within my data, my sampling approach became more theoretically driven (see Figure 3.3 for overview), in keeping with grounded traditions (Strauss & Corbin, 1997; Gioia, Corley & Hamilton, 2013). This led me to focus on two specific groups at the heart of the commercialization of QKD. These were the Research & Development (R&D) department, and the Customer-Serving Units (CSUs), who I distinguished according to the type of activity they were corporately accountable for. Using the notion of exploratory and exploitative activities (March, 1991; Levinthal & March, 1993), the R&D department were TechCorp's solitary exploratory business unit who were responsible for providing innovation to the organization. The CSUs, on the other hand, were the organization's exploitative business units who were tasked with capitalizing on extant resources and capabilities and selling them to customers, in order to generate revenue.

In this manner, while my unit of observation was the QKD project, my unit of analysis was the group-level. Within these groups, I engaged with managers from across the organizational hierarchy who were involved in the process of (attempted) commercialization, characterising these actors as either top, middle or operational managers. This distinction followed other scholars in the field (e.g. Huy, 2001; 2011; Vuori & Huy, 2016), where middle managers were defined as those who were two levels beneath the company CEO and one level above operational managers. Generally speaking, top managers were responsible for the strategic direction of TechCorp, whereas middle and operational managers were engaged in the day-to-day tasks required for innovation.

Following grounded traditions (Straus & Corbin, 1998), I continued to collect data until the point of theoretical saturation. The notion of saturation is that additional data collection provides no new insights about a category or concept (Strauss & Corbin, 1998), and thus Charmaz (2003) suggests this has occurred when new data fits into pre-existing categories. From February to August 2020 (7 months), I continued to collect and analyse data, however this shed little additional insight other than to reinforce what I already knew. Given the time-bound nature of doctoral studies, I felt that this sufficiently constituted saturation, therefore exiting the field.

In total, this sampling strategy led to the generation of a body of primary data amounting to 81 semi-structured interviews, over 200 informal conversations and observations of 72 separate events. My primary data was complemented by secondary data consisting of over 3,000 A4 (1.5 spaced) pages of document analysis, which provided me with a vast and rich body of qualitative data from which I could theorize (for an overview of the data collected, see Table 3.4).

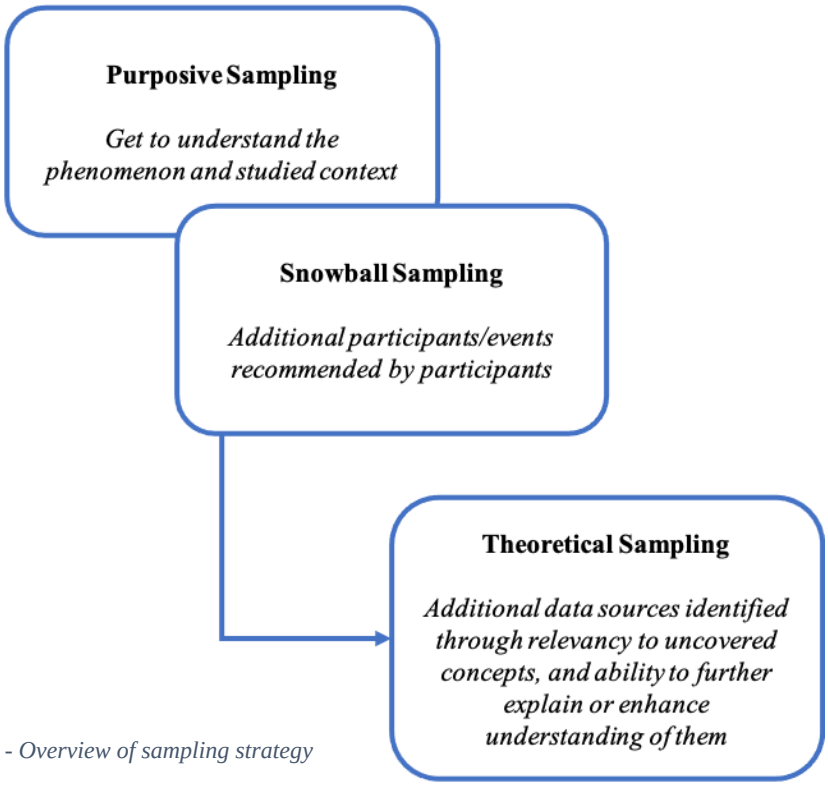


Figure 3.3 - Overview of sampling strategy

Table 3.4 - Overview of data collected and how it was used in analysis

Data Source	**Total # of Items**	**Duration (Hours)**	**Total Pages (A4, 1.5 Spacing)**	**Use in Analysis[21]**
Semi-Structured Interviews	81	107	1,360	• Data on the origins of QKD, as well as its subsequent development, both at TechCorp and more broadly. Exploring rationales behind selection of QKD over alternative methods of providing quantum-secure communications. • Understand the lived realities of participants involved in the attempted commercialization of novel technology (i.e. QKD). This included the thoughts, feelings, and opinions of participants with respect to the commercialization of QKD. • Gather information relating to the different activities and processes that group members were participating in and why. • Opportunity to examine social dynamics in privacy, where participants could be honest and without fear of repercussion. Ability to probe why participants supported/opposed courses of actions, particularly when their thoughts or feelings were divergent with the rest of their group. • Gain contextual/historical information on the innovation process at TechCorp.
Informal Conversations	272	40 (approx.)	174	• Opportunity to check understanding 'off the record' as well as to triangulate findings from interviews and observations, where participants may be behaving in a socially desirable manner. • Gain a further, deeper understanding of social dynamics. • Insight into latest 'organizational gossip' and news, particularly with respect to commercialization of QKD. Chance to comprehend what was considered important or potentially controversial as an indicator of where further investigation might be necessary.

[21] How each source of data was used varied according to the stage of analysis. Further detail on how each data source was used in each stage of analysis is available in Table 9.

Observations	72	63	185	• Provided naturalistic insight into the taken-for-granted aspects of reality when it came to commercializing novel technology. In particular, offered insight into conventions of interaction and communication that were not readily observable or understood through interviews or document analysis. • See – first-hand – the activities and practices involved in trying to commercialize novel technologies like QKD. Also, an opportunity to see how the social dynamics between different groups of actors, such as R&D and the CSUs, different levels of management, and between TechCorp and external organizations (e.g. collaborators, customers, government) existed and played out. • Understanding of the decision-making process with respect to selection of, and commitment, to novel technologies.
Document Analysis	81	N/A	3,359	• Source of contextual and background information, especially regarding TechCorp's corporate direction and attitude towards QKD. • Helped with triangulation of insights. Press insights helped to overcome corporate rhetoric. • Enriching the data set with third-party insights.

3.5.2 Semi-structured interviews

I carried out 81 semi-structured interviews, which were all audio recorded and transcribed verbatim. My informants were predominantly from TechCorp's R&D department to begin with, as I tried to understand how innovation was 'done' at the organization and what was being done with regards to commercializing QKD. As my understanding developed, it became clear that the interaction between R&D and the CSUs was critical because for an innovation to succeed they had to cross a chasm between the two departments. This led me to interviewing a number of CSU managers and personnel. My informants came from across the organizational hierarchy, which ensured that I was able to develop a broad understanding of the phenomenon and how it was perceived by different areas of the organization. I also spoke to numerous actors external to TechCorp, to help understand how TechCorp were trying to commercialize QKD from an outsider's point of view. These informants came from a variety of sectors and organizations including government, companies developing or selling QKD, potential consumers, as well as academic and scientific institutions.

Throughout this process, informants were selected because they were deemed to be knowledgeable agents who understood what actions were being taken and why (Gehman et al., 2018). Initially, my interviews focused on understanding the innovation process at TechCorp – what it was, how well it worked and what challenges or frustrations existed. Participants were invited to reflect on their own experiences of trying to pursue and commercialize novel innovations and offer suggestions about how it might be done better. As the research progressed, these interviews focused solely on the commercialization of QKD, often regarding specific events I had observed or knew had taken place. I drew on the open-ended interview technique as described by Vuori (2018) to help me understand the emotional experiences of participants, using interviews to probe and understand the participant's point of view, as well as to check my own understanding of emerging issues. In this manner, I entered interviews with a number of pre-defined open-ended questions to discuss to ensure that the questions I asked were relevant to, and were addressing, my research question(s). However, this allowed me to retain flexibility to explore interesting and relevant avenues of discussion that emerged during the course of the interview (Spradley, 1979).

Generally, interviews lasted between 40 to 60 minutes, however some interviews were as short as 25 minutes whereas others lasted up to 180 minutes. Once out of the field, these interviews were transcribed verbatim and anonymised. All interviews were triangulated with observational data and documents (Jick, 1979) in order to assess the veracity of claims made. At regular intervals in my investigation, I also used interviews as an opportunity to carry out member checks (Lincoln & Guba, 1985) to test and refine my emerging insights.

Although my study was conducted in real-time, there were instances where participants were required to recall events retrospectively. To guard against hindsight biases, I used courtroom-style

questioning (Eisenhardt, 2007) in an attempt to enhance the accuracy of informant responses. This involved asking about concrete events and facts, rather than interpretations. However, there were also instances where I asked participants to recall how they felt about certain events. Research in psychology has shown that individuals can recall emotionally charged events with high levels of accuracy (Fisher, Ross & Cahill, 2010), but to further improve the quality of answers I asked informants to explain and attribute these feelings as much as possible. Wherever possible, questions about retrospective events were asked to a number of informants to enable triangulation of multiple interviews, as well as with other data sources.

3.5.3 Observations

Alongside semi-structured interviews, I saw observational data as a key source of data, because it was an opportunity for me to see how the pursuit of novel technological opportunities occurred in an incumbent organization in real-time, and in its "natural context of occurrence" (Adler & Adler, 1994, p.378). Observational data was therefore a valuable source of naturalistic insight (Lincoln & Guba, 1985; Shah & Corley, 2006) that was free from retrospective bias (Pettigrew, 1990). I had unfettered access at TechCorp, which allowed me to attend a wide variety of events, including a weekly team meeting on QKD; workshops with customers and collaborators; government-funded project meetings; industrial and academic events[22]; as well as internal meetings between R&D and CSU managers during which decisions would be made regarding the commercialization of QKD. As I established sufficiently high levels of familiarity and trust, I was invited to informal events with members of the community, such as lunches, coffee breaks and even social events like after work drinks and celebratory meals. Intensive observation of this kind allowed me to understand how things actually happened (Watson, 2011) across the various sites and settings in which the TechCorp community lived (van Maanen, 2010). It allowed me capture nuances and non-verbal subtilities that would have been otherwise missed (Langley & Abdallah, 2011), as informants are either unaware of them or reluctant to talk about them. Importantly, I was able to see and comprehend the taken-for-granted aspects of reality that would otherwise be missed in interviews or document analysis. For example, I could observe the nature of relationships between different individuals and groups who were involved in the commercialization of QKD, and probe these further to understand why these relationships were enabling or prohibiting the process.

I assumed a role as a non-participant observer (e.g. Kaplan, 2008; Jarzabkowski, 2008), although participants were aware of my identity and my purpose for being there. Given innovation is an inherently social activity (Garud, Tuertscher & Van de Ven, 2013), I paid particular attention to the

[22] During the first year of my PhD, I attended a number of academic and industrial conferences pertaining to quantum technologies in order to familiarise myself with the context I was studying. However, in the main body of data collection, I only attended industrial events as they related to my refined research problem.

interactions between groups, tracking how these changed and developed over the period of study. In my field notes, I documented fundamental details such as the time, date, duration and purpose of events, who was present and why, as well as the topics of discussion, information shared, emotional reactions[23] (e.g. laughter, raising of voices, frowning). I predominantly paraphrased conversations, however when something particularly notable or pertinent was said, I captured it in verbatim quotes. At the end of each day in the field, my observations were typed up, and I added my thoughts, reflections and ideas which I could refer back to as the research progressed.

In total, I spent a total of 63 hours in the field and made observations of 72 distinct events across a variety of sites (i.e. multi-site ethnography – Marcus, 1995), which led to the generation of 185 pages (A4, 1.5 spaced) of field notes. Wherever possible, my observations were carried out face-to-face (Jarzabkowski, Bednarek & Cabantous, 2015), however there were instances where my observations were virtual (e.g. Kaplan, 2008). Many facets of organizational life are increasingly conducted digitally using software like Skype and Microsoft Teams[24], so despite not being readily observable by the naked eye when video is not shared, these events still offered valuable insight into the language, actions and perceptions of informants (Hine, 2000; Akemu & Abdelbour, 2018). Equally, organizational actors may present different versions of themselves on- and off-line, which made it pertinent for me to conduct both physical and digital observations in order to provide a truly authentic account (Golden-Biddle & Locke, 1993) of the phenomenon.

Although no two days of observation were the same, I spent time around managers and actors working on the QKD project, assuming a desk in the same office space at TechCorp's R&D headquarters whenever I was on-site. On days where there were events that I would be observing, I would often shadow managers for most of the day, going for coffee breaks and lunch with them, which provided me with a less formal space to probe and ask questions to check and advance my understanding. When I conducted virtual observations, I would reach out and talk with the relevant informants via email or text on the day to get a feel for what was going to take place, and ensure I was aware of any keys opportunities or apprehensions they held. A particularly important source of observational data was the weekly meeting I attended, which involved discussions of all news, activities and developments related to QKD. This environment was very much treated as a 'safe space' by managers and employees involved in the project, and therefore they often voiced honest thoughts and feelings, giving me extraordinary insight. I always logged onto the weekly team meeting at least 5

[23] As I will explain in Section 3.5, my explicit focus on emotions did not occur until almost a year in the field, at which point in time I paid increasing focus to emotions (e.g. expression, suppression). However, in my early field notes I still acknowledged how people behaved and often alluded to what sort of emotional state or mood participants demonstrated.

[24] Given the COVID-19 pandemic and subsequent limits on national movement that occurred in March 2020, the vast majority of work at TechCorp moved online. In this respect, the increasing use of virtual ethnographic methods is understandable.

minutes before it began, which gave me another opportunity to engage in informal 'water cooler talk' and get a sense for the prevailing mood and emotions. After observations – both physical and virtual – I would try and catch up with at least one or two attendees as a way of ascertaining their thoughts and feedback on the latest happenings. This also provided me with a forum in which I could check my own understandings.

As I progressed throughout the research process, the purpose and focus of my observations shifted. To begin with, these observations helped to orient me to key routines and activities associated with innovation at TechCorp and come to grips with what it meant to innovate at the organization. As my research progressed, I became more focused in my observations and would keep a close eye on particular actors, interactions, decisions, and what was (not) said. For example, when my research became explicitly focused on the role of emotion, I paid closer attention to non-verbal cues such as body language and facial expressions, as these can be indicative of emotional states (Ekman, 1992; Elfenbein, 2007). These non-verbal cues were identified through ocular observation, and recorded in my field notes through descriptions. For example, I recorded how participants in meetings might have shown a frowning facial expression, consisting of downturned eyebrows and a furrowed brow. I would note down the features I had noticed, and what I thought they might be experiencing. Similarly, I tried to record any body language that stood out. For example, when participants were shaking or nodding their head in (dis)agreement during meetings indicating their (dis)pleasure or (dis)agreement; looking off into the distance, perhaps indicating their boredom; or possibly a folding of arms and hunched body posture. Given that I was 'learning on the job' in terms of studying emotion, my ability to record these non-verbal indicators of emotion could be described as relatively naïve. However, my capacity to capture this information improved throughout the research process. I also predominantly used this data in support of more explicit claims of emotion, or verified through follow-up conversations with the participant(s) in question where possible, rather than relying solely on it.

Langley and Klag (2019) have suggested that whilst proximity in ethnographic observation can breed value knowledge and insights, it is not without risks. They identified four risks in particular that researchers ought to consider:

(1) *Reactivity*: the researcher's presence and actions may affect the nature of the phenomenon;

(2) *Going native*: the researcher will be socialized and unable to think clearly or critically;

(3) *Alignment*: the researcher might become politically aligned to an organizational faction.

To mitigate against the risk of reactivity, I adopted a position as a non-participant observer, meaning that I did not engage with the participants that I was observing (Lee 1999; e.g. Liu & Mailtis, 2014), other than introducing who I was and why I was there, in order to attain informed consent. To ensure that I did not 'go native' I adopted an insider-outsider dichotomy (Gioia, Corley & Hamilton, 2013) whereby I discussed my insights with others who were not in the field with me (i.e. were

outsiders). These individuals were therefore well-placed to play devil's advocates and critique my interpretations as necessary (Van Maanen, 2011), and highlight where they thought I might be misinterpreting. These individuals were my two supervisors, as well as two close colleagues who were also pursuing their doctorates in management and also using qualitative methods. Finally, to mitigate against the risk of alignment, I kept a research diary in which I could reflect on my experiences in the field and analyse where I may be becoming aligned. I also used my weekly supervisor meetings and supervisors (who behaved as 'outsiders') as a space in which I could get honest feedback from a detached source about whether I appeared to be aligned or not. Finally, I ensured that I engaged with informants from both the R&D department and CSUs at TechCorp on issues, to try and ensure that I always had captured both perspectives and could see from both points of view.

3.5.4 Document Analysis

I also amassed a significant body of secondary data in the form of documents from both publicly available and private internal sources. This data was comprised of notes from team meetings; email chains; organizational strategy and innovation documents; PowerPoint presentations on TechCorp's innovation process and endeavours; PowerPoints presentations on QKD that were used externally with customers and funding bodies; almost 10 years' worth of TechCorp Annual General Meeting (AGM) presentations and reports; news and media reports on QKD spanning two decades; conference and journal papers on QKD written and delivered by TechCorp employees; government white papers and publications on QKD and its attempted commercialization. A detailed summary of the documents I collected is provided in Appendix 6, and information regarding how they were used in the analysis is available in Table 3.6, as well as Appendix 6.

Documents were another valuable source of naturalistic data, given that such documents are created without any input from the researcher (Atkinson & Coffey, 1997; Bowen, 2009). Although Atkinson and Coffey (1997) suggest that documents – as a source of secondary data – shouldn't be used alone because they cannot provide an all-encompassing account of a phenomenon, by using them alongside interviews and observations I was able to conduct multiple source triangulation (Miles & Huberman, 1985) and enhance the veracity of my claims. Where data converged, it suggested that this was an accurate representation of reality. The use of multiple sources therefore helped me to overcome any potential bias in a given data source (Denzin, 1970; Patton, 1990).

During the early stages of my investigation, these documents were useful to help orientate me to the context and history (Edmondson & McManus, 2007) of innovating at TechCorp, as well as the background of QKD at the organization and beyond. At this stage of the investigation, I collected these documents from publicly available sources on the internet, using Google searches as well as Lexis Nexis, with my search terms centring on TechCorp and quantum key distribution. My Lexis Nexis search provided me with 80 relevant articles dated between 1999 and January 2019 (another 81 were subsequently identified throughout the research process until August 2020). My Google searches

provided me with a multitude of documents including TechCorp AGM invitations and slide decks, company annual reports and government publications. These sources allowed me to develop initial lines of questioning for interviews, as well as developing a case history that could help to mitigate informant retrospective bias when recalling past events (e.g. Zuzul & Tripsas, 2019).

As the research process developed, I continued to collect new documents from publicly available sources like Google and Lexis Nexis (e.g. latest government releases and news on QKD). However, I increasingly gained access to private documents, provided by informants, both at TechCorp and other organizations. These informants provided me with documents such as techno-economic analysis reports, strategy documents, collaborative project reports, as well as organizational memos relating to QKD. Whilst some of the documents helped to guide the investigation and provide a line of inquiry, they were predominantly used for the purpose of triangulation to help establish the validity of claims made by informants, or inferences that I wished to make about the phenomenon, following others in the field (e.g. Cornelissen, Mantere & Vaara, 2014; Raffaelli, 2019; Zuzul, 2019). For example, when informants told me that the government were very keen on QKD, I analysed government white papers and strategy documents to see whether or not this was the case. This analysis confirmed the claims made by informants, showing that around $1.5 billion had been invested in quantum technologies, as well as providing a roadmap that highlighted how QKD was likely to be critical for securing the nation's critical infrastructure in an era with large-scale quantum computers. Similarly, using internal documents produced on TechCorp's strategy and innovation process, I was able to compare how the pursuit of QKD compared to the planned innovation process and identify significant divergence, which provided me with a line of inquiry for my subsequent data collection efforts.

3.6 Ethical Approval

The ethical implications of social science research have become increasingly prominent, meaning that it is crucial to consider how the research aims, questions, methods and outputs might negatively impact or cause harm to the research participants. Ethical approval was sought before any data collection took place, in which potential risks were considered, and mitigation strategies developed and detailed. As I moved institution after I had begun the collection of my data, my ethical approval was received whilst at Leeds University Business School, provided by ESSL, Environment and LUBS (AREA) for research from Leeds University Research Ethics Committee (see Appendix 1). Upon my transfer to Durham University, I ensured that I followed the ethical guidelines provided by the Business School as well.

Although I might have been considered an honorary member of TechCorp by many participants, my involvement was contingent on a Non-Disclosure Agreement (NDA) that was ascertained as part of my agreed access to TechCorp. As I was not an employee of the host organization, this helped to avoid

any conflict of interest. This NDA is not included in the appendices due to it having information which clearly reveals TechCorp's real identity that cannot be removed.

3.6.1 Informed Consent

Gaining informed consent from informants is not a one-off but rather an ongoing endeavour, as the research develops. To do so, it was necessary to be clear with what was expected of participants at any given time. I remained transparent throughout the research process about what I was seeking from interviews and observations, which I found to be helpful because it not only primed informants, but allowed them to suggest people to talk to, events to observe and even documents that might be relevant to furthering my research.

Meaningful consent meant that information needed to be shared and communicated with participants regarding the nature of my research, and what would be expected from them, which I detailed in an information sheet (see Appendix 2). Given the geographically dispersed nature of actors, and desire to maintain participant anonymity, I shared information sheets with potential participants via email, which contained the key information of the research aims, objectives, rationales, as well as contact details for both myself and both supervisors, should the participant have any question or queries.

Before any interviews took place, I would provide informants with a copy of the same information sheet for them to read if they had not already done so, as well as provide them with an overview of the participation details (aims of research and how they would be contributing; anonymity; voluntary participation; right to withdraw). I always would seek both verbal and written consent on recording. Where no recording was made, consent was gained via a consent form.

3.6.2 Anonymity

All participants were assured anonymity when participating. To achieve this, all project data was kept in a password-protected folder on my personal laptop (which only I had access to). The laptop itself was also password protected. All back-ups were kept on an external hard-drive, which was stored in a locked cabinet at my residence.

Identifying features were removed from transcripts at the earliest possible opportunity, both personal and third-party. One potential risk was that participants might be identified by other group members, given the nature of the QKD project: it was a relatively small number of actors within TechCorp and from collaborative partners and government who were – by and large – known to each other given the size of the community. A low level of risk was attached to the possibility that certain emotions – for example, anger or frustration – might be attributed to individuals or groups, leading to social harm (damage to social networks or relationships) for either the informant or that group. All information gathered was largely as expected with the experience of a complex, collaborative project such as commercialization of technology.

Where necessary, any controversial or potentially damaging responses from interviews were not used for direct quotation. For example, if a respondent claimed "The recent failure of the QKD project to progress has been down to Bob: he is incapable of getting things moving" then I would report this as feelings of frustration with regards to management maintaining the momentum of the project. In this way there was a reduced likelihood that either the respondent or party they were referring to being negatively impacted by my research. As a further step to protect my informants, I have opted to place my thesis under embargo for 5 years, at which point in time the sensitivity of information will have diminished sufficiently.

3.7 Data Management

All interviews were audio recorded, allowing transcription once out of the field. By recording the interviews, I was able to focus on holding a natural conversation rather than attempting to write in-depth field notes. Once out of the field, transcription could occur. Whilst transcription was time-consuming, it enabled me to develop a high-level of familiarity with my data (Rubin & Rubin, 2011) which I feel led to more nuanced insights subsequently.

Given the size of my data pool, I utilized NVivo and Microsoft Excel in order to keep a track of my analysis. NVivo is a popular computer aided qualitative data analysis software (CAQDAS) in social science research (Saunders, Lewis & Thornhill, 2009), which helps researchers to organize, code and retrieve data. NVivo's primary purpose in this research was to organize all data files – of which there were almost 200 – in one easily accessible file/location. I also utilized NVivo's coding capability to carry out my initial first-order coding, because it allowed me to easily see what aspects of my data had been analysed. Having coded my data, I then transferred these in vivo, raw codes into a formatted Microsoft Excel spreadsheet to conduct my second-order coding and further analysis.

Whilst many conventionally use NVivo for all stages of their qualitative data analysis, I found that Excel was a more effective tool personally. It allowed me to see all of my data – from raw interview segments all the way up to assigned aggregate dimensions – easily on one screen. I found this more suitable for recoding and the collapsing of categories during data condensation, as I could easily insert new columns for further coding, or hide existing ones. This was particularly useful when asking others for their interpretations of my coding, as I could easily hide my codes and provide them with space to do their own coding. I felt that this also allowed me to achieve a greater degree of transparency – the "degree of detail and disclosure about…specific steps, decisions and judgement calls made during a scientific study" (Aguinis, Ramani & Alabduljader 2018, p.83) – as I could keep all iterations of my coding and data analysis in one document, rather than having multiple files.

3.8 Data Analysis

3.8.1 Abduction

In accordance with grounded traditions (Strauss & Corbin, 1997), data collection and analysis occurred concurrently. Once data was collected, it was analysed, allowing concepts to emerge that could inform further investigatory efforts, as well as for more data to help refine emerging concepts (i.e. theoretical sampling). At the heart of a grounded approach is to remain data-driven, constantly refining the research question or problem according to emerging insights (O'Reilly, Paper & Marx, 2012).

When I initially entered the field, my analytical approach was open-ended and inductive (Strauss & Corbin, 1998; Gioia, Corley & Hamilton 2013). However, an emerging puzzle quickly appeared within my data. I observed that despite the CSUs at TechCorp rejecting QKD and explicitly stating they did not want, nor see value in, the technology, the R&D department continued to develop QKD and press the CSUs to accept it. Accordingly, my analytical approach became abductive (Gioia, Corley & Hamilton, 2013; Mantere & Ketokivi, 2013), as I sought to explain this puzzle using my data and the extant literature. My research therefore followed the growing trend in scholarly inquiry to use abduction as a means of generating new theoretical insights (e.g. Cornelissen, Mantere.& Vaara, 2014; Smets, Jarzabkowski, Burke & Spee, 2015).

Abductive theorizing begins with a surprise or puzzle that arises inductively from the empirical data, leading the researcher to ask 'what is going on here?' (Alvesson & Kärreman, 2007). Researchers proceed by developing possible conjectures that could explain this empirical puzzle, in consultation with the existing literature (Timmermans & Tavory, 2012). These alternative explanations are then tested out in recursive phases of induction and deduction (Klag & Langley, 2013) to find which theory best fits and explains the empirical puzzle. The iteration between new data, old data and existing literature can be seen as the constant comparative method (Strauss & Corbin, 1998) in action. This process allows theoretical insights in the empirical data to be increasingly developed to higher levels of abstraction in conjunction with the existing literature (Locke, Golden-Biddle & Feldman, 2008). Although my brief description of this process presents it as linear and straightforward, the actual process itself involved a myriad of steps and different analytical tools and techniques, which are described in the next section and summarised in Figure 3.4, as well as Tables 3.5 and 3.6.

3.8.2 Stages of Analysis

Stage 1: Possible theoretical explanation - Building Ecosystems

At the very outset of my research, I entered the field to try and understand how and why some incumbents were able to successfully pursue novel technological opportunities, whilst others were not. In keeping with grounded traditions (Strauss & Corbin, 1998) I had established a partial but unelaborated theoretical framework that I took into the field to guide my investigation. Based on insights from early document analysis – which seemed to emphasize collaboration with other entities

up- and down-stream from TechCorp to help understand and develop the technology – I hypothesized that TechCorp were pursuing novel technological opportunities through the creation or development of a business ecosystem (Jacobides, Cennamo & Gawer, 2018) which would allow them to bring QKD to market. At this stage, my research question was *"How do incumbents build ecosystems to commercialize complex innovations?"*

Knowing that I was looking at a processual phenomenon, my initial analysis involved the development of a timeline of events, following the strategies proposed by Langley (1999) for theorizing from process data. Based on secondary data, I developed a timeline that included all key events and activities, such as collaborations, academic insights, as well as when press releases or media comments were made by top managers regarding QKD. I also engaged in first- and second-order coding of initial interviews (Gioia, Corley & Hamilton, 2013) and observations, looking for examples of practices and activities that managers were undertaking to achieve this outcome that indicated inter-organizational collaboration of some sort.

However, the codes and categories emerging from my initial inductive investigation made it clear that the phenomenon I was observing was intra- rather than inter-organizational. For example, I had codes referring to activities like "Prospecting about future prospects of QKD" which was something that R&D managers were doing in order to generate and provide answers to their counterparts in the CSUs about QKD in order to try and get the official go-ahead to proceed with commercialization. This was indicative that building an ecosystem was not at the crux of this story.

More poignantly, I found myself perplexed by the dynamics between the R&D department and the CSUs at TechCorp that I was observing. Despite the CSUs – who made decisions regarding which innovations to commercialize and sell – being quite explicit that they saw little value in QKD, and did not anticipate it being of any interest for a number of years, managers in the R&D department remained convinced about its efficacy and continued to push the technology hard for its immediate commercialization.

Stage 2: Possible theoretical explanation - Disruptive innovation

Conventional wisdom would suggest that in instances where an innovation is not deemed useful by those with decision-making authority, the R&D department would divert their time and effort to other innovations and streams of work. However, their belief and support for QKD was persistent. As I tried to address this puzzle, I became more abductive in my analytical approach (Mantere & Ketokivi, 2013), seeking potential explanations for this dynamic from the literature. Initially this led me to think that QKD might be a disruptive technology or innovation (Christensen, 1997) and that the divergent beliefs were because the CSUs' did not see how it could serve their existing customer segments. Accordingly, the CSUs preferred to maintain the status quo and more incremental forms of innovation that could better serve these customers. There also seemed to be activity reminiscent of interactive

framing (Goffman, 1974), as the R&D department tried to convince the CSUs to change their position. This led to me refining my research question, to consider: *"How do managers in incumbent organizations frame disruptive innovations in order to facilitate their pursuit?"* This possible theoretical frame and research question emerged on the basis of the reading I was conducting at the time around disruption and disruptive technologies and innovations, which emerged from discussions that I had held with my supervisors in supervisory meetings.

I continued to collect and analyse more data, using the process of first- and second-order coding as described by Gioia, Corley & Hamilton (2013). My further collection sought to understand the nature of QKD, while my analysis sought confirming evidence of my hunch regarding QKD as a disruptive technology, looking through transcripts, observations and documents for descriptions or characteristics that might indicate elements of disruption. However, my informants were clear: whilst the technology departed significantly from existing knowledge and resource bases and thus could be characterised as a radical innovation, they did not consider it to be disruptive in the sense that it altered market or industry dynamics, which was the crux of Christensen's (1997) initial theory of disruptive technology. Rather, QKD was an alternative way of continuing to serve a market and customer segment, using new knowledge and resources. It would not introduce new entrants to the market for secure communication but represent a shift in the technology that current organizations used to provide this outcome. The lack of disruption to market structures and industry dynamics meant that my participants disagreed this could be at the root of the dynamics between R&D and the CSUs. Additionally, my data highlighted a number of activities that were not purely communicative, indicating a need to broaden my research question from its explicit focus that it currently held on framing. In this respect, disruptive innovation provided poor data-theory fit, meaning that I continued with the process of abductive theorizing in order to find a better fitting theory.

Stage 3: Possible theoretical explanation - Managerial orchestration capabilities

Since the core of the observed phenomenon was the ability of an incumbent to try and innovate, I considered the literature on dynamic capabilities (Teece et al., 1997) for potential answers. During discussions with my supervisors, we spoke about the need for managers within incumbent organizations to align a variety of different 'pieces in a puzzle' in order for novel technologies to be commercialized. This spurred me to examine the micro-foundational research that explored how managers orchestrate and organize for certain outcomes (e.g. Sirmon & Hitt, 2011; Giudici, Reinmoeller & Ravasi, 2011; Helfat & Peteraf, 2015), to see if this could help explain my empirical observations. Early in my interaction with this literature, I noted that there was correspondence between a number of my emerging second-order themes and the actions or activities that were described in papers I was reading. For example, in their discussion of the mental activities that managers engage in order to facilitate organizational dynamism, Helfat and Peteraf (2015) described how managers used language and communication to aid reconfiguration, and also how reconfiguration could be constrained by extant

knowledge structures and beliefs. Equally, they spoke of perceiving as a key aspect of sensing opportunities. These resembled my second-order themes, such as the communicative framing of QKD as an opportunity, as well as how managers were 'prospecting' about the technology, which were future-oriented attempts at imagining or perceiving how it might emerge that seemed potentially important to sensing and seizing the technological opportunity. Thus, my guiding research question became: *"How do managers in incumbent organizations orchestrate the pursuit of novel technological innovations?"* reflecting the fact that my data indicated actions outside of solely communication, thus dropping the narrow focus on framing.

Although this helped to identify a number of activities related to how managers were identifying opportunities and threats related to QKD and attempting to act upon them (i.e. sensing and seizing activities [Teece, 2007; 2014]), it still could not totally account for the divergent beliefs regarding this technology. However, in reading Hodgkinson and Healey's (2011) work on the psychological foundations of dynamic capabilities and the role that emotion could play in the innovation process on the recommendation of one of my supervisors, I began to see observe semblance between what my data described, and what these scholars were describing. Their discussion of hot and cold cognition – or emotion-laden and emotion-less forms of cognition – seemed to resonate with the beliefs espoused by the R&D department and CSUs respectively. Whilst managers in R&D saw QKD as a 'cool' new technology and seemed emotionally invest in its commercialization, the CSU managers were comparatively emotion-less in their position and argued that it was not worth their while commercializing because – economically – it would not deliver value.

Stage 4: Possible theoretical explanation - Emotion

Given the coherence I observed between my empirical data and the idea of hot and cold cognition (Hodgkinson & Healey, 2011; 2014), I began to probe in detail whether the perplexing dynamics I had observed (and continued to observe) could be explained by emotion. I took 10 of my early interviews and began to re-code them with an explicit focus on identifying both explicit and implicit instances of emotion. Explicit instances of emotion (e.g. "I am scared of X") were easily identifiable, while I followed others in the field of strategy and innovation (e.g. Huy, 2011; Vuori & Huy, 2016; In-Press; Vuori, Vuori & Huy, 2018) and used appraisal theories of emotion (e.g. Lazarus, 1991c) to identify and infer implicit emotions. For example, instances of fear can be inferred when individuals describe that potential harm might occur to them, and that they have a low or uncertain ability to address or avoid the threat.

I considered the characteristics of interview data, and how these corresponded Lazarus' (1991a – see Table 3) componential model of emotion and particularly his core relational themes, which conveyed the essence of different emotional experiences, as well as Smith and Ellsworth's (1985) model of complex cognitive appraisals. Taken together, I arrived at what I confidently believed the emotion to be, revealing instances of fear, pride and envy amongst this small sample of re-coded interviews.

Having identified instances of emotion in this interview data, I then considered these experiences in light of my observational field notes and documents I had collected across the same period of time. I found that certain emotional experiences seemed to correspond to different courses of (in)action, which could account for the puzzling empirical dynamics that I had initially uncovered. As my field notes and document analysis also indicated the presence of emotion, I was confident of the theory-data fit. For example, in media reports (Archival Documentation) regarding TechCorp's QKD breakthroughs, R&D managers I had interviewed were quoted as being *"extremely excited*" about the prospects of the technology. Similarly, in my field notes I had recorded instances of frustration, joy and particularly worry, with respect to taking actions which might result in the failure of the QKD project (i.e. fear of failure). It seemed that emotion played a salient role in the pursuit of novel technology and attempted innovation at TechCorp, and that the emotions experienced by R&D managers influenced both how they thought and behaved. To check my insights, I got two researchers not involved in either data collection or analysis to repeat the same procedure with regards to my interviews. As our findings converged, this further corroborated my suspicion.

Throughout my consultation of the literature, I had become increasingly aware that our understanding of how emotion affects the innovation process is limited. In fact, during the process of abduction I came across a number of pieces of work that explicitly called for work that foregrounded the role of emotion in (attempted) innovation, in order to offer more behaviourally plausible accounts of this process (Hodgkinson & Healey, 2011; Gavetti et al., 2012; Vuori & Huy, 2016; Brusoni et al., 2020). Accordingly, my research problem was again refined, with an explicit focus on the role of emotion within the pursuit of novel technology in incumbent organizationns. Clear evidence of managers communicative efforts, as uncovered in Stage 2[25], also remained apparent, leading me to pursue two related research questions:

(1) How do managers communicate novel technological opportunities in incumbent organizations, in order to gain the attention and support of key organizational decision-makers?

(2) How does emotion affect the pursuit of novel technological opportunities in incumbent organizations?

[25] Whereas previously I used the concept of framing (Goffman, 1974; Cornelissen & Werner, 2014), given my research had begun to lean more heavily on theories of managerial cognition deriving from the behavioural perspective (March & Simon, 1958; Cyert & March, 1963), I opted to adopt the language of this literature and thus referred to managerial communication rather than framing.

Stage 5: Addressing my research questions on emotion and managerial communication of novel technological opportunities

At this stage, I re-coded my data to illuminate all instances of emotion, whilst further data collection and analysis became more emotion-centric. For example, during interviews I ensured I asked people how they felt about things, whilst in observations I paid close attention to the emotions that actors demonstrated, including both verbal and non-verbal cues, since emotions can be expressed and may be identified through body language and behaviour (Elfenbein, 2007; Fisher, 2019). As my analysis sought to explain how emotion affected the pursuit of novel technological opportunities in large, established organizations – i.e. the emergence and evolution of a phenomenon over time, through activities and events (Cloutier & Langley, 2020) – I took inspiration from others in the field (e.g. Cornelissen, Mantere & Vaara, 2014; Compagni, Mele & Ravasi, 2015) and combined a number of process theorizing strategies as proposed by Langley (1999) to help with my analysis.

While I had developed a visual timeline or 'map' of events in the early stages of my analysis, updating the map when pertinent actions, events or outcomes took place, I now sought to integrate and populate this map with my codes, particularly those regarding the emotions experienced by key groups and actors (for an example of such a visual map, please refer to Appendix 7). Visually representing data allows researchers to see multiple dimensions and processes concurrently (Langley, 1999), and this helped me to establish when different emotions were experienced by different actors, and begin to identify what the potential antecedents and consequences of different emotional experiences were. The process of integrating my codes to my visual map permitted me to discern a number of time periods according to the prevalent/prominent emotion, and I was subsequently able to decompose my data into discrete but connected chunks (Langley, 1999). Each chunk could then be examined individually and in detail to identify different actions and outcomes, thus beginning to establish tentative relationships between emotional experiences and actions taken to commercialize QKD to answer my research question. This process also helped make me aware of key turning points within my data (Cornelissen, Mantere & Vaara, 2014), and this heightened awareness helped me to establish relationships between different second-order themes and begin to form some provisional aggregate dimensions.

For example, I could see a clear emergence of fear in the R&D department, although I was unsure what triggered this change. Upon re-examination of my data, my field notes showed that there had been a quarterly review meeting held between managers in the R&D department and CSUs, in which top managers from the CSUs had unequivocally voiced no interest or support for the technology. As they were responsible for determining whether or not QKD would be added to the portfolio of products and services they offered (i.e. whether it would be commercialized or not), it appeared that this was construed as a threat or danger to the corporate goal of delivering breakthrough innovation to the organization by managers in the R&D department. Subsequently, fear responses manifested, given the consequences that they deemed failure would entail for the department. Similarly, in the period

following this manifestation of R&D's fear of failure, I noticed that managers in the R&D department were much more proactive in trying to convince the CSUs about the efficacy of QKD. They invited them to more meetings, renewed efforts to advance customer trials, and engaged with government. In my observational field notes, I recorded increasing instances of R&D communicating the economic value of QKD, especially speculative future revenue figures, as a means to attracting their attention and promoting CSU engagement with the technology. These communicative efforts were intended to raise the appeal of QKD by aligning it with the CSUs' corporate goals and aspirations, and encourage them to accept the technology for commercialization. Doing so would allow R&D to meet their corporate goals around delivering breakthrough innovation, thus avoiding failure and addressing the fear of failure they experienced. Having identified key emotions, actions and outcomes in these periods, and how they may interrelate with one another, I was able to take these insights and weave them into a coherent narrative that addressed my research questions.

Table 3.5 – Stage-by-stage breakdown of data collection and analysis carried out

	Theoretical frame	**Data Collected**	**Guiding research question(s)**	**Reason for selection of theoretical frame**	**Reason for rejection of theoretical frame**	**Analytical steps/techniques involved**
Stage 1	Business ecosystem emergence and development	Interviews = 17 Observations = 3 Events Informal Chats = 49 Document Analysis = 1,795 pages	*How do incumbents build ecosystems to commercialize complex innovations?*	Early insights suggested the pursuit of QKD required TechCorp to orchestrate upstream and downstream actors holistically. This corresponded with the literature on developing business ecosystems	Concepts emerging from data analysis indicated phenomenon was intra- rather than inter-organizational	Visual mapping of events First- and second-order coding of data Triangulation with other data sources
Stage 2	Disruptive innovation	Interviews = 13 Observations = 14 Events Informal Chats = 35 Document Analysis = 398 pages	*How do managers in incumbent organizations frame disruptive innovations in order to facilitate their pursuit?*	The nature of the interactions between R&D and CSUs seemed consistent with those described in papers I was reading around the time on disruptive technology and innovation	Informants defined QKD as a radical, but not disruptive, technology	Visual mapping of events and activities First- and second-order coding of data Triangulation with other data sources Member checks
Stage 3	Managerial Dynamic I & Orchestration	Interviews = 17 Observations = 10 Events Informal Chats = 45 Document Analysis = 810 pages	*How do managers in incumbent organizations orchestrate the pursuit of novel technologies?*	Emerging second-order themes corresponded with concepts discussed in papers on managerial orchestration of resources and assets	Still could not explain perplexing dynamics between managers from the R&D department and the CSUs	Visual mapping of events and activities First- and second-order coding of data Triangulation with other data sources Member checks

Stage 4/5	Emotion	Interviews = 33 Observations = 42 Events Informal Chats = 143 Document Analysis = 520 pages	*How does emotion affect the pursuit of novel technological opportunities in incumbent organizations?* *How do middle managers communicate novel technological opportunities in incumbent organizations, in order to gain the attention and support of key organizational decision-makers?*	Supervisor recommendation to read Hodgkinson and Healey (2011) paper on basis of perceived similarities. Consistency between dynamics in data and notion of 'hot' emotion-laden and 'cold' emotion-less cognition that authors discuss in paper.	N/A – Theoretical frame was deemed appropriate and therefore not rejected.	Visual mapping. Second-order codes integrated onto visual map as a way of establishing antecedents to, and consequences of, different emotional experiences. Subsequent temporal bracketing to further aid analysis. First- and second-order coding of data Triangulation with other data sources Member checks

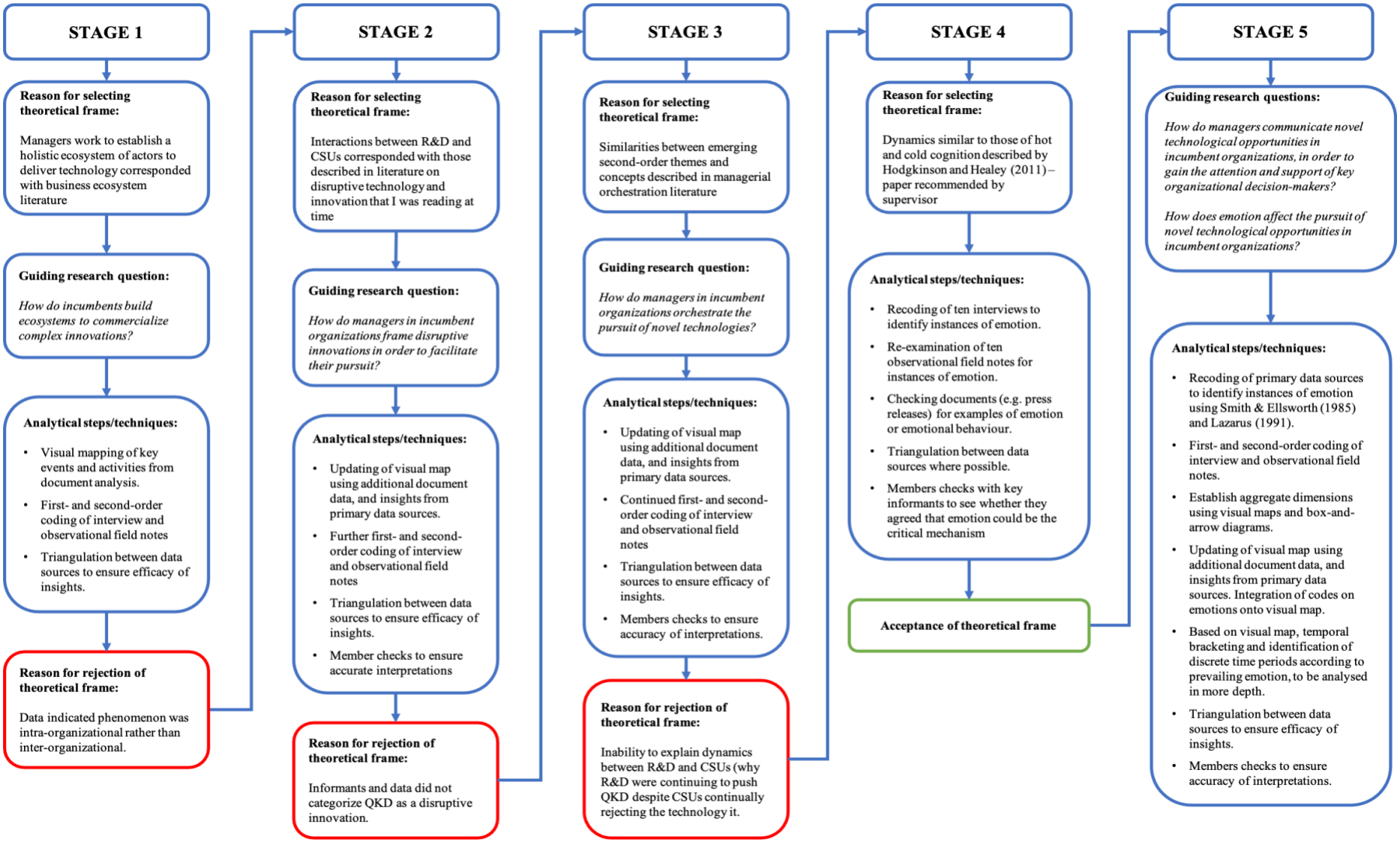


*Figure 3.**Error! Unknown switch argument.** - Overview of analysis process, stage-by-stage*

*Table 3.**Error! Unknown switch argument.** - Detailed breakdown of how data sources were used in each stage of analysis*

Data Source	**Purpose/Use**				
	Stage 1	**Stage 2**	**Stage 3**	**Stage 4**	**Stage 5**
Semi-Structured Interviews & Informal Chats	Develop understanding of how TechCorp innovate, and what it means 'to do innovation' at TechCorp, from the perspective of those within R&D department, as well as external actors they collaborate with. Explain main challenges faced; understand constraints on successfully innovating. Understand perceptions of QKD at TechCorp, as well as what prior work and experiences there had been. Get a grasp for where the project/innovation was going.	Probe the divergent interpretations of QKD between managers in the R&D department and the CSUs. Understand what sort of innovation the R&D department defined or categorised QKD as. Understand the social and political dynamics between groups at TechCorp, as well as the relationship TechCorp had with government and collaborators regarding QKD. Who supports and opposes the project and why. Understand why QKD had been made become a specified goal for the R&D department, and what this involved.	Understand what managers in the R&D department were doing and why to develop the market for QKD. Comprehend what specific challenges that were being faced by the R&D department, and what actions were being taken to address these challenges. Build better understanding of position of the CSUs, and how they envisioned future of QKD manifesting. Get to grips with how the heightened level of scrutiny was impacting (daily) work.	Explicitly appreciate the different ranges of emotion that managers were experiencing; particular emphasis on getting to the root of fear of failure as experienced by managers in the R&D department. Understand the change in perspective/position of the CSUs with regards to commercializing QKD, from an outright 'no' to something they were beginning to consider.	Probing and clearly understanding the source of CSU ambivalence. Understand dynamics between CSUs and R&D department, specifically with regards to the collaborative offers put forwards by OptiCo and Red Tech.

		Comprehend short-, medium- and long-term goals and intentions for the QKD project.			
Ethnographic Observations	Familiarising researcher with how innovation is 'done' at TechCorp through observing both internal and external meetings and workshops Understand social dynamics between individuals/groups Begin to understand who the key actors/personnel are in the pursuit of QKD at TechCorp, as well as within collaborating organizations.	Further understanding of social dynamics, through observation of team meetings, as well as meetings with other groups and personnel in R&D and CSUs. Try to discover reasons why R&D/CSUs had such divergent opinions on QKD. Continued identification of key actors and groups. Comprehend the 'everyday realities' involved in pursuing innovation/QKD at TechCorp R&D. Gain insight into deliverables, aims and objectives imposed on actors and the QKD project. See how TechCorp R&D were interacting with external actors (collaborators, customers) at customer workshops and industrial events.	Keep up-to-date on the latest activities and news related to QKD through team meetings. See how the internal dynamics in R&D department were changing as a result of departmental goal to commercialize QKD, and heightened interest from top management. Understand how collaborative projects were progressing. See how TechCorp were presenting QKD to external audiences as they tried to develop interest and support for the innovation. Understand the nature of various collaborative relationships, as well as how others actors in QKD domain were acting.	Appreciation and demonstration of everyday actions and activities being taken to commercialize QKD; particular emphasis on the interactions taking place between the R&D department and CSUs. Show how the R&D department were positioning QKD with the CSUs, as well as how the CSUs were responding. Empirical examples of fear of failure amongst R&D department, as well as the CSUs' ambivalence towards QKD.	

Document Analysis	Become familiarised with the history of innovation and QKD at TechCorp through media reports, organization documents and publications. Understand the market and landscape of QKD, particularly government support. Also understand which organizations and institutions were actively involved in the attempted commercialization of QKD. Develop initial lines of questioning, and create a timeline and case history.	Develop better understanding of the different collaborative projects that TechCorp were involved in, which aimed to commercialize QKD. Particularly, find out what TechCorp's specified purpose or role was. Uncover medium- and long-term strategic direction of TechCorp to see how QKD fit. Help to provide further lines of questioning. Also to facilitate multiple source triangulation.	Appreciate TechCorp's longer-term ambitions with QKD, according to market analysis and reports Grasp how QKD was seen from a governmental perspective, in terms of its need, and their investment plans for the technology	Corroborate insights and statements made by R&D department and CSUs with regards to why to (not) pursue and commercialize QKD. Understand the growth and development of QKD market(s), and customers interested in the technology. Keep up-to-date with external market changes and news that make QKD more or less palatable – e.g. commitments made by Japanese government to have a satellite QKD programme.

3.8.3 Member Checks

At regular intervals throughout the research process, I presented preliminary findings and insights back to my participants and discussed my thoughts with them, as a way of performing member checks (Lincoln & Guba, 1985; Shah & Corley, 2006). The intention of member checks was to ensure my insights accurately reflected the lived experiences of my participants (Pratt, Kaplan & Whittington, 2019). This feedback proved invaluable to refining my insights and emerging theoretical model. For example, participants were able to highlight that R&D's fear of failure was multi-faceted and stemmed from a lack of interest and support from the CSUs (internal) as well as a lack of customer interest (external). Recognizing that fear of failure therefore stemmed from internal and external sources, I was able to return to my analysis and distinguish between the two. Furthermore, while I had some apprehensions whether fear of missing out was merely a subset or unique form of fear of failure, participants emphasised that they thought fear of missing out was a critical emotion and mechanism in the process, which encouraged me to keep and build upon fear of missing out in my model.

My member checks included six separate presentations with middle and operational managers across the R&D department and CSUs, in which I showed them emerging theoretical models and we spoke about my interpretations, as well as their thoughts. These sessions were relatively informal and often preceded or followed an interview, and thus were held with individuals I deemed to be key informants. More formally, I gave presentations to top managers in the R&D department on two separate occasions. This involved the presentation of a slideshow involving my interpretations, supporting evidence and a summary of what the key related literature said, which these managers reflected and provided feedback on. Both presentations lasted approximately 90 minutes. At the culmination of my research (June and July 2020) I presented my findings and emergent model back to six informants across the R&D department and CSUs as a way of validating my model. These informants held a variety of hierarchical positions and roles. In these meetings, all members confirmed that the account I had constructed accurately captured their experiences of the QKD project, and although many said that some of the reflections made them sad, this was not because of any factual inaccuracy but merely having to accept painful home truths.

3.8.4 The Coding Process

The coding of my data followed the steps described by Gioia, Corley and Hamilton (2013). In this respect, my analysis is best described as grounded-*like* rather than true grounded theory (e.g. Glaser & Strauss, 1967; Strauss & Corbin, 1998). Although I drew on a Straussian grounded theory research strategy, the formulaic coding process provided by Strauss and Corbin (1998) proved to be cumbersome and hindered my ability to make adequate progress. With the increasing prevalence of the Gioia method in qualitative research published in top-tier academic journals (e.g. Vuori & Huy, 2016; Dattée, Alexy & Autio, 2018; Grimes, 2018; Gaim, Clegg & Cunha, 2019; Smith & Besharov, 2019; Warner & Wäger, 2019), I found this process allowed me to achieve qualitative "rigor without rigor mortis" (Eisenhardt,

Graebner & Sonenshein, 2016, p.1113). The Gioia method allowed me to discover nuanced insights, while also allowing me to make progress with my dissertation. My decision to use Gioia et al. (2013) seemed appropriate given that this coding method was inspired and based on the process described by Strauss and Corbin (1998), involving iterative phases of first-order (open) and second-order (axial) coding, which culminated in the distilling of second-order themes into overarching aggregate dimensions. Additionally, Corbin and Strauss (2008) commented that their coding process was intended as a framework or toolbox for qualitative researchers – especially doctoral students – to use, rather than hard-and-fast rules on how coding should proceed. A particularly useful output of the Gioia method was a visual data structure (see Figure 3.5), which aided theorizing and the development of visual models and representations of my findings. Although the following process is described linearly, it was a recursive and iterative process which occurred throughout the stages of analysis described in Section 3.6.2.

Step 1: First-order coding.

My first-order codes adhered to informant terminology as much as possible and I made little effort to distil these into any sort of categories early on (Gioia, Corley & Hamilton, 2013). As a result, I generated 1,635 separate first-order codes in total, which were largely 'in vivo' codes. These adhered to the terminology of participants as much as possible, to prevent the forcing of preconceived ideas onto my data. During Stages 4 and 5 of my analysis, when the focus became more explicitly on emotions, I allowed myself to infer implicit emotions based on Smith and Ellsworth (1985) and Lazarus (1991)[26]. Since my research proceeded through a number of stages and held different theoretical focuses, some codes which related to a specific stage (e.g. those relating to building business ecosystems) later became redundant. Accordingly, by the time I arrived at my theoretical model, the number of first-order codes used was approximately 1,200 in total, with over 400 dismissed due to a lack of relevance to my research questions.

Step 2: Second-order coding.

Using the constant comparative method (Strauss & Corbin, 1998; Gioia, Corley & Hamilton, 2013), I looked for similarities and differences amongst these first-order codes as a way of distilling similar codes into second-order themes of a more theoretical and abstract nature. Again, the labels of these second-order themes utilized participant terminology where possible to prevent the forcing of preconceived ideas onto my data, and to maintain the experiences of my informants. Since the phenomenon of interest was inherently processual, these codes became gerunds wherever possible (Gioia, Corley & Hamilton, 2013), to help maintain the dynamic nature of the innovation process being studied.

[26] For further detail, please refer back to the analysis process described in Section 3.5.2 Stage 4 & 5.

These second-order themes provided tentative answers and insights into my research questions. In this manner, these second-order themes also guided further data collection, as I sought to collect insights that could elaborate on these concepts and their relationships (i.e. theoretical sampling – Strauss & Corbin, 1998). Given scholars recommend having between 20 and 30 second-order themes (Gioia, Corley & Hamilton, 2013), the development of additional second-order themes was typically followed by periods in which I would attempt to reduce the number of second-order themes in order to keep them at a manageable number. This occurred through condensation (Grodal, Anteby & Holm, 2020), where similar themes were subsumed under one heading, and a process of interrogation, during which I would examine my second-order themes and ask myself how they answered my orienting research question. If I deemed them to no longer be relevant or helpful in answering my research question(s), I would discard them.

For example, at the beginning of Stage 5 of my analysis I had 47 second-order themes in total. I found that I had generated numerous themes pertaining to "Worry." These included "Worrying about project progress" "Worrying about likelihood of success" "QKD failing to meet objective performance aspirations" and "Senior management pressure for progress." Accordingly, I subsumed this data under a solitary theme called "Worrying about the QKD project." Equally, I had a number of codes regarding discussions with government over establishing an innovation centre captured under the theme "Trying to establish an innovation centre." However, as this theme failed to explain my research questions around how emotions affect the pursuit of novel technological opportunities, nor how managers articulated such opportunities to gain attention and establish support. Accordingly, I removed this theme from my data. This process allowed me to reduce my second-order themes from 47 to 22, a much more manageable number.

During these later stages of my analysis, some themes were re-coded using terms from the literature, in keeping with abductive traditions (Mantere & Ketokivi, 2013). This helped me to refine my insights and ensure I was contributing to theory by building on or extending existing concepts rather than coming up with synonyms (Gehman et al., 2018). For example, the category "Worrying about the QKD project" was re-labelled as "R&D's fear of failure" building on the likes of Mitchell and Shepherd (2011) and Cacciotti et al. (2016; 2020). Through continued consultation with the literature, I found that this theme related to future-oriented concerns about the aversive consequences of failing to deliver QKD, which closely corresponded to what these scholars had called fear of failure. Accordingly, changes to the code/label seemed appropriate.

Step 3: Establishing aggregate dimensions.

The final stage of coding involved establishing relationships between my second-order themes that could answer the posed research question(s), and categorizing them into aggregate dimensions (Gioia, Corley & Hamilton, 2013). This process generally only occurs when there is a reasonably high level of confidence in the second-order themes, therefore I only engaged in this final stage of coding

during Stage 5 of my described analysis. Upon categorizing second-order themes into aggregate dimensions, a data structure can be produced, to help with theorizing and to help the development of visual models.

At this stage, I asked myself, "what is going on here?" and how the 22 remaining second-order themes I had could best describe and explain the phenomenon of interest. Referring back to my visual map (Langley, 1999) – which I had updated with second-order themes as they occurred temporally throughout the analysis process (refer to Stage 5 of Analysis in Section 3.5.2 for discussion of visual map creation) – I was able to link certain themes together as antecedents and consequences of certain emotions or actions[27]. For example, I could see that following the experience of fear of failure, the R&D department began trying to communicate the benefits of QKD to the CSUs in terms of various aspirations or goals it would help fulfil. Similarly, I had evidence that in the months following these communicative efforts, the CSUs began to experience a simultaneous fear of failure and a fear of missing out. In this manner, the visual map allowed me to build box-and-arrow diagrams (for example, see Appendix 8) and develop a tentative process model, based on the chronology of my data.

The process of developing box-and-arrow diagrams using my second-order themes allowed me to see the emotional dynamics involved in the pursuit of novel technology at TechCorp clearly, and identify a number of rough stages. Briefly, this involved an initial period of inertia, followed by the experience of fear of failure in the R&D department, and a period where R&D acted based on their fear. Based on the actions of R&D, I had evidence of the CSUs' emotional experience and response, as well as their subsequent action.

Further refining my model, I was able to distinguish between the antecedents of inertia and the actual occurrence of inertia, creating a six-stage model. In order to label my aggregate dimensions, I simply described what was taking place at that point in the process, using terms derived from my second-order themes where possible to keep my model 'grounded.' The only exception here was the aggregate dimension "CSUs' Emotional Ambivalence" which was chosen in light of the literature on ambivalence (Rothman et al., 2017) to reflect the behavioural consequences of the fear of failure/fear of missing out as experienced by the CSUs.

[27] The process of using my visual map and creating box-and -arrow diagrams further enabled me to condense and distil a number of my second-order themes under one heading. For example, I had themes labelled "Technology's low level of internal and external support," "Technology's uncertain future prospects," "Technology's uncertain value to TechCorp," "Low levels of progress creating worry" and "Senior management pressure for progress" which all preceded the fear of failure as experienced by the R&D department on my visual map. At this point, I realised that that these were all factors contributing to and driving R&D's fear of failure, and that these factors could be distinguished as being either within or beyond the organizational boundary (i.e. were internal/external). Thus, I re-labelled these categories simply as "Internal drivers of R&D fear" and "External drivers of R&D fear." This process was repeated across my themes to reduce from 22 to 14 second-order themes.

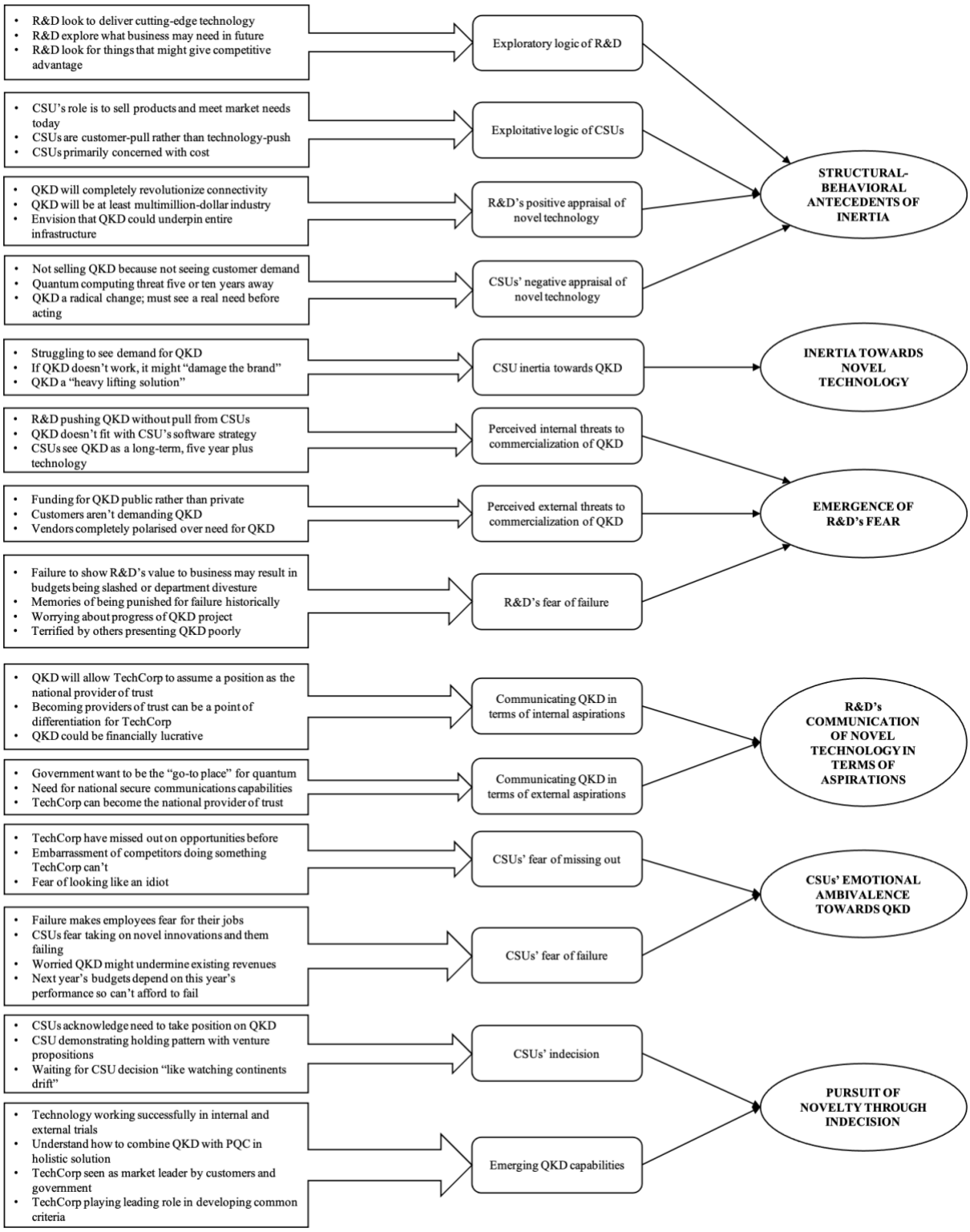


Figure 3.5 – Data structure for developing theoretical insights from raw data

3.8.5 Identifying the presence of emotion in my data

The initial identification of emotion within the data came about as a result of conversations with my supervisors regarding possible explanations for the perplexing dynamics between the R&D department and the CSUs. During these discussions, my supervisors commented on the presence of emotion in interview transcripts, as well as in the descriptions of events I had recently observed and informal conversations I had held with participants (during which there was frequent references made to their concerns and/or worries regarding the progression of QKD at the organization). Having been directed to the Hodgkinson and Healey (2011) paper on the psychological foundations of dynamic capabilities, the notion of 'hot' emotion-laden cognition and 'cold' emotion-less cognition seemed a plausible explanation for the puzzling dynamics I had observed, leading to a pilot coding exercise of ten early interview transcripts and sets of observational field notes.

In the first ten interviews, I looked for explicit references to emotional states (e.g. "It makes me happy"). I found that my informants had referenced to a variety of different emotions that they were experiencing, or had experienced, such as fear, pride, joy/happiness, jealousy, nervousness/anxiety/worry, frustration and anger. Fear was particularly prominent, with many informants using established synonyms for fear (see Lazarus, 1991c; Scherer, 2005) including anxious/anxiety, apprehensive/apprehensions, nervous, worry/worried/worries and concern(ed) with respect to various aspects of the QKD project. Equally, in my field notes I had recorded a number of different voiced concerns, worries or fears held by various actors and groups involved in the attempted commercialization of QKD.

The number of emotion-related codes I was able to generate in this small subset of my data set suggested that good theory-data fit might exist, leading to an expanded re-coding exercise across a broader sample of my data. Again, numerous references were made to fear and its synonyms throughout both interviews and in field notes of observed events. This provided corroboration for the working hypothesis that emotion was salient in the pursuit of QKD at TechCorp, and so I proceeded to re-code the entire data set for instances of emotion. Throughout this process, the prominence of fear and related concepts like anxiety and worry resulted in a focus being placed on the role that fear played in the studied case.

Given that participants sometimes are unable to convey their emotional experiences, or perhaps unwilling to explicitly do so, I also sought to infer emotional experiences from statements that were made in interviews. Following established protocols for identifying emotion in qualitative research (e.g. Huy, 2011; Vuori & Huy, 2016; Vuori, Vuori & Huy, 2018; Kanitz, Huy, Backmannn & Hoegl, In-Press; Vuori & Huy, In-Press), I used Lazarus (1991c) to help identify when informants were talking about fear, without ostensibly using terms like fear, scared, terrified, horrified, etc. The core relational theme or 'essence' of the experience of fear and anxiety, according to Lazarus (1991c), is a threat or

danger to the self[28]. Thus, I coded instances of fear when informants spoke about how undesirable things may happen to them, whose outcomes were uncertain, and over which they had a limited or uncertain ability to control or address the threat.

There were also instances where I was able to infer emotional experiences based on non-verbal indicators of emotions, as in Vuori and Huy (2016), and as recommended by Kouamé and Liu (2021). Research has shown that emotion can often be displayed and inferred via facial expressions and other non-verbal cues like body language (Barsade, 2002; Ekman & Friesen, 2003; Elfenbein, 2007; 2014). Aside from explicit claims made in interviews, I compared descriptions recorded in my observational field notes of the facial expressions, behaviours and bodily gestures of participants that I had observed with extent research which linked them to specific emotional experiences (e.g. Matsumoto et al., 2008, Chapter 13; Öhman, 2008; Damasio & Carvalho, 2013; Barrett, Adolphs, Marsella et al., 2019). Combined with participant follow-ups to understand how they had felt (where possible) this allowed me to infer emotional experiences with a reasonable level of confidence.

For example, during one participant described how they had been made to "shudder" (i.e. involuntary shake or tremble) during a meeting, which is a known physiological response to both disgust and fear (Rozin et al., 1993; Matsumoto et al., 2008, Chapter 13). Further probing enabled me to distinguish that this behaviour was most likely a result of the individual's experience of fear, as they recalled how they had suddenly realised that they may fail in the commercialization of QKD, which entailed potential harms. Similarly, I tried to record – particularly when my empirical focus became explicitly on emotion – in my observational field notes, the bodily gestures and facial expressions of those participating in events that I was observing (as discussed briefly in Section 3.5.3).

Another example from my observational field notes was how, during a team away day that I was observing, I witnessed facial expressions that appeared to indicate surprise or horror exhibited by numerous participants when they heard the news that the Head of R&D had targeted and promised the commercialization of QKD within two years. In my notes, I recorded a description of their faces – such as how they had taut facial muscles, dropped jaws/open mouths and wide eyes, and how they remained frozen in place – seemingly paralyzed by this news – for a number of moments before reacting to the news that had been delivered. Follow up discussions with participants involved in this event in the next coffee break and over lunch indicated that they had been scared by this news, and what failure would entail. Thus, I surmised that this was likely to be a physical manifestation of fear, whilst comparisons

[28] Lazarus (1991a; 1991c) distinguished between 'fear' (or fright) and 'anxiety' in his work. The essence of fear was an immediate and concrete threat of harm, whereas anxiety involved existential, uncertain threat. However, as conveyed by Cacciotti and Hayton (2015), fear and anxiety have a shared core meaning – about a danger or threat, concrete or uncertain – and therefore I chose not to distinguish between the two. Lazarus (1991c) in fact commented that not all scholars differentiated between the two. This has previously been discussed in depth in Section 2.3.4.

of the expressions with those described and shown in the literature on facial expressions was also consistent with the experience of fear (Ekman & Friesen, 1978; Matsumoto, Keltner, Shiota, O'Sullivan and Frank, 2008, Chapter 13). Relatedly, during team meetings, I noted down how certain managers might be nodding or shaking their head, indicating their (dis)agreement with the topic or a point being made. In other notes, I recorded how participants appeared to be staring into the distance, possibly indicating boredom or disinterest (Fisher, 2018), or maybe crossing their arms and closing off their body, which might indicate a number of emotions, such as disinterest or perhaps that they felt under attack (Harrigan, Rosenthal & Scherer, 2008). Again, follow-ups were critical to ascertain the accuracy of my perceptions. Whilst I was careful to combine observations of non-verbal expression of emotion with follow-ups to try and ensure accurate insights, they nonetheless provided me with a useful segue into understanding how individuals might be feeling (Elfenbein, 2014).

3.8.5.1 Identifying that participants and groups were 'fearful'

Given the challenges associated with accurately identifying emotion (which will be discussed in Section 3.8.5.2), it is pertinent to explain how I arrived at the conclusion that my informants felt fear (i.e. were fearful). It is also important to note that whilst some scholars (e.g. Lazarus, 1991a; 1991b; 1991c; Öhman, 2008; Brusoni et al., 2020) distinguish between fear and anxiety on the basis of whether the threat is concrete and immediate, or more existential and uncertain, I chose to conflate fear and anxiety (Smith & Lazarus, 1990; Cacciotti & Hayton, 2015; Cacciotti et al., 2016; 2020), on the basis that the essence of fear and anxiety is about (potential) danger and threat, and therefore are sufficiently similar to treat without distinction for the purposes of this research.

As discussed, I primarily relied on informants' self-reports of fear, which I identified through the use of words associated with fear and anxiety, which included: fear, anxious, nervous, worry, worrying, worried, apprehensive, terrified, horrified, doubt(s), concern(s), dread, afraid, scare(d), trepidation and panic. These words are synonyms of fear and anxiety according to the Geneva Affect Label Coder (GALC), which is a list of standard words used for different categories of emotion (Scherer, 2005), and also discussed by Lazarus in *Emotion and Adaptation* (1991c). I found more often than not participants would use less intense synonyms for being scared or fearful, which was attributed by to the fact that openly displaying or discussing emotions, both within TechCorp and more broadly within society, was somewhat frowned upon. Alongside explicit claims of fear, I also inferred the experience of fear from statements that described potential harm that might occur, the outcome of which was uncertain, and which the informant(s) claimed to have a low or uncertain capacity to cope, following established precedents (e.g. Huy, 2011; Vuori & Huy, 2016). As mentioned in the previous section (3.6.5.2) I was also able to infer fear through facial expressions that I observed participants make during my field work, comparing the records I made with literature on emotional facial expressions (Ekman & Friesen, 1978; Matsumoto, Keltner, Shiota, O'Sullivan and Frank, 2008, Chapter 13; Barrett, Adolphs, Marsella et al., 2019). I also followed up with these participants to

ascertain how they had felt, to ensure I corroborated my interpretations, and wherever possible would follow up with others who were present to get their interpretation of events.

Given I studied two groups involved in the pursuit of novel technology, my level of analysis was the group-level. I therefore followed recommendations offered by Kozlowski and Klein (2000), to help identify when fear was and experienced within groups at TechCorp and thus became 'shared.' I deemed that shared, group-level fear had been experienced when multiple individual group members reported that they had experienced fear, and described similar appraisals. For example, numerous R&D managers told me how the threats to commercializing QKD caused them to experience a fear of failure because they knew that the consequences of failure were harmful or threatening to the R&D department, in terms of its budgets, and whether or not it would continue to be funded. In this manner, when "individual-level data…[revealed] substantial within-group agreement or homogeneity" (Kozlowski & Klein, 2000, p.216) pertaining to the experience of fear, I was able to suggest that fear had become shared and experienced at the group-level.

To help ensure that assertions of fearfulness were accurate, wherever possible I sought to triangulate my insights. Primarily, I sought witnesses who could provide their own account of the event(s) in question. When convergence existed, it was an indication that the account was an accurate representation of emotion, allowing me to be more confident that fear was indeed felt. Similarly, when I observed events, I sought to capture non-verbal cues[29] (e.g. facial expressions) that could provide additional indicative evidence whether the emotion in question was indeed experienced (Kouamé & Liu, 2021). These were then followed up and probed for their efficacy after the events had finished, on a one-to-one either informally or through interviews, as to avoid any potential socially desirable responding. Claims were also verified using appraisal theories of emotion (Smith & Ellsworth, 1985; Lazarus, 1991c) for the key appraisal patterns associated with the experience of fear.

Finally, I regularly engaged in member checks (Shah & Corley, 2006) of my interpretations, when I asked informants whether the interpretation that fear had been experienced was correct, as well as to verify what the eliciting stimulus or cause had been. This was generally carried out on a one-to-one basis ($N = 31$) or in small groups of less than four ($N = 6$) during coffee breaks or lunches. Largely[30], respondents agreed with the interpretation that fear was experienced, and verified the eliciting stimulus as the potential consequences of failing to meet organizational/departmental goals (R&D's fear of failure; CSUs' fear of failure) and the potential embarrassment from failing to deliver QKD (CSUs'

[29] There is an argument to be made that non-verbal displays could be 'performances' in a Goffman-esque sense (1974), and not true representations of how participants actually felt. However, combined with follow-up discussions with the individuals in question and others who were also present, I felt confident in my assertions.

[30] There were five occasions where my interpretations were challenged by informants. However, only on one occasion did any informant(s) conclude that fear was not experienced. On the other two occasions, there was contention over what exactly was eliciting the fear, rather than the experience itself, and these discussions allowed this contention to be cleared up.

fear of missing out). I also carried out six formal feedback presentations and sessions to verify my emergent theoretical model with participants from across TechCorp's business units and organizational hierarchy, who had been involved in the attempted commercialization of QKD. Again, during these sessions my insights that managers and groups felt fear were corroborated. On a number of occasions, participants of feedback sessions even elucidated on the nature of fear further, providing additional examples that they believed were relevant. This allowed me to be confident in the assertion that managers at TechCorp felt fear.

3.8.5.2 Addressing the challenges of studying emotion qualitatively

Despite established precedents for identifying internal emotional experiences qualitatively, through interviews, direct observations and even documents (Huy, 2002; 2011; Maitlis & Liu, 2014; Vuori & Huy, 2016; Kouamé & Liu, 2021), certain challenges exist and require consideration. The principal challenge faced by qualitative emotions research relying on informants self-reported feelings is an unwillingness or inability on behalf of informants to accurately share their feelings with researchers. Additionally, as Nisbett and Wilson (1977) put, "we sometimes tell more than we can know" (p.247), an issue that is particularly acute when engaging in retrospective investigation. The ability for accurate introspection has been widely scrutinized, with research suggesting that whilst individuals may be able to recall and describe the outcome of higher-order mental processes (e.g. what emotion they experienced), they often struggle to access and describe *why* they have experienced them accurately (Nisbett & Wilson, 1977; 1978; Wilson, 2003; Wilson & Dunn, 2004). For example, when explaining why fear was experienced, an informant generally relies on implicit, a priori theories formed about the world regarding causal connections between a stimulus and a response (Schachter, 2002) rather than what necessarily occurred. Further challenges faced with accurate self-reporting of emotion include the potential socially desirable responding, as well as suffering from evaluation apprehensions.

The issues associated with retrospective recall were somewhat mitigated by the fact that I studied the phenomenon of interest largely in real-time rather than retrospectively, meaning that informants did not have to dig deep into their memories to recall events. When interviewing or talking to informants, I asked how they felt about things primarily, opposed to why they necessarily felt that way, which helped to avoid the need to reconstruct previous appraisals (Ericsson & Simon, 1993; Wilson & Dunn, 2004). When discussing retrospective events, I used courtroom-style questioning, asking informants to provide concrete examples and events including what happened, where it happened, and when it happened, to encourage informants to use episodic rather than semantic memory, which is said to produce more comprehensive and accurate accounts (Tulving, 2002). Research also suggests that high arousal events are better encoded and remembered (Christianson, 1992). Given that the principal emotion studied in this research – fear – is considered a high arousal emotional state (Russell, 1980; Plutchik, 2001), this provided further confidence that informants would be able to recall events accurately.

Wherever possible, I sought to speak to other informants who had witnessed or been present at recalled events, who might be able to provide information that could corroborate and verify claims (i.e. enable triangulation). For example, when one informant told me that another manager was fearful during a specific meeting, I was able to speak with three others who had also been present at that event and interacted with the individual in question, drawing the same conclusion. Furthermore, I used other data sources wherever possible, to aid triangulation (e.g. combining observational data with informal conversation and interview data). Finally, I used the prototypical appraisal patterns associated with specific emotions (as specified by cognitive appraisal theorists – e.g. Smith & Ellsworth, 1985; Frijda, 1986; Lazarus, 1991c) as a way of evaluating statements of emotional experience. When statements of emotion converged with the prototypical appraisal pattern of that hypothesised emotion, this suggested that the emotion accurately reflected what they had experienced.

In order to lessen the risk of socially desirable responding, I built rapports with informants, and repeatedly observed, interviewed and interacted with them. Doing so made it less likely that emotional tactics could be used (i.e. behaving a certain way despite feeling differently) because it would require prolonged effort and would likely be detected throughout the research process (Huy, 2002). Equally, as I built relationships with participants, they were more inclined to act naturally and honestly around me. Doing so allowed me to become an organizational 'insider', and to comprehend the rules and norms for emotional displays and expressions that existed and governed organizational employees. I was told that emotion wasn't something employees necessarily spoke about freely, or were encouraged to display throughout their daily routines. This reiterated the need to establish trusting rapports with participants, who I could encourage to be open and honest about their thoughts and feelings. I found that participants often would hint at their emotional experience – voicing concerns or worries, for example – and during follow-up conversations or interviews would divulge the extent of their thoughts and feelings.

3.8.6 Making Causal Inferences

Given the ontological and epistemological position used in this research, the notion of causality adopted differed from the conventional Neo-Humean idea of constant conjunction of events and correlation (Brady, 2003; Bennett & Elman, 2006). Critical realists recognize that conducting research in open systems means that constant conjunction of events is unlikely to occur, and it difficult – if not impossible – to control for all the potential critical variables. As such, critical realists understand causation as a process of identifying mechanisms and capacities that might lead from cause to effect (Brady, 2003). Single cases are believed to be beneficial in this endeavour because researchers can generate detailed knowledge and understanding of the case and hypothesize what causes and mechanisms could be interacting to produce a particular outcome (Collier, Brady & Seawright, 2004, Chapter 13; Maxwell, 2012). A central tenet of critical realism is also that knowledge of the world is tentative and fallible (Bhaskar, 1979), and therefore researchers from this paradigm generally suggest opposed to definitively claim causal relationships, when engaging in qualitative field research. The

strength of causal inferences typically depends on the degree to which alternative explanations can be ruled out, which researchers seek to achieve through collecting a rich and detailed body of data, using multiple sources that permit triangulation to assess the veracity of any claims or insights, as well as through member checks where participants can help assess what explanation fits with their experience (Collier et al., 2004; Maxwell, 2004; 2012; Modell, 2009). There is also an emphasis on the researcher as a reflexive and knowledgeable agent to determine the degree to which their evidence supports a given explanation and rules others out, another reason why an ethnographic approach with prolonged immersion in the field for data collection can be beneficial in critical realist research.

In order to arrive at my proposed causal explanations, I was retroductive in my analysis. Thus, having observed an event, I asked myself: what must be true of the world for this to have happened? I then relied on the rich data and understanding I had developed to identify possible causes or explanations, testing these out by collecting further data and seeing whether it supported these assertions (or not). Critically, because I had collected multiple different types of data, I was able to use triangulation not only to test claims and insights made for their accuracy, but in doing so, also assessing my emerging causal explanations. When different data sources converged and supported a given explanation, I could be reasonably confident that this had indeed occurred. Finally, I constantly engaged in member checks with participants to assess whether my emerging hypothesized causal explanations corresponded with their versions of reality. Since I was not able to control for all other potential variables, my causal explanations are therefore suggested opposed to definitively claimed, which is consistent with other single-case qualitative studies (e.g. Maitlis & Ozcelik, 2004; Huy, 2011), based on the evidence that I had at my disposal. Thus, I offer analytical rather than statistical generalizations.

4 Findings

In the preceding chapters, I have introduced and explained the motivation for investigating how incumbent organizations pursue novel technological opportunities; why I am paying particular attention to how managers communicate such opportunities to decision-makers, as well as the role that emotion plays within this process; and provided an overview of the grounded ethnographic approach to the investigation. In the following section, I will present the findings of my study in three distinct phases. These three phases will then be synthesised into a process model which explains how emotion can affect the pursuit of novel technological opportunities in incumbent organizations in Chapter 5. These phases capture key periods which I uncovered during my time in the field, consisting of an initial period of inertia (Phase 1); a period characterized by high levels of fear in the R&D department, brought about by the CSUs' inertia towards novel technologies like QKD and subsequent reappraisals made (Phase 2); and a final period in which the CSUs demonstrated ambivalence towards QKD following R&D's communicative efforts, which seemed to stem from their experience of dual fears of missing out and of failure, and culminated in a period of indecision in which QKD began to emerge (Phase 3). At the start of each phase, I will present part of the model, which is then subsequently elaborated on and explained in the following text. Additional illustrative data for each aggregate dimension is offered at the end of the respective section.

4.1 Phase 1: Inertia at TechCorp

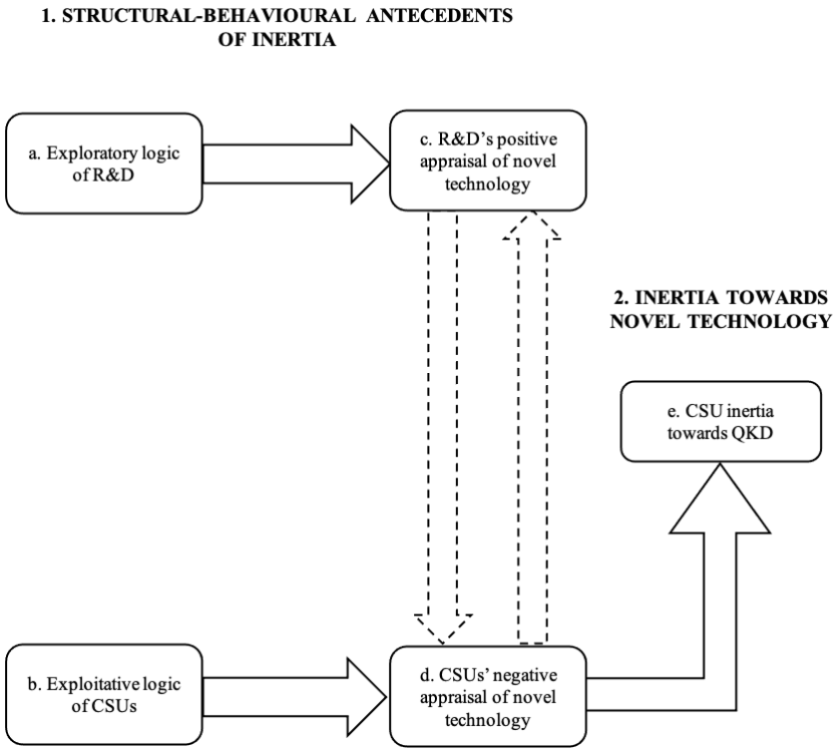


Figure 4.1 – Summary of Phase 1

Structural-Behavioural Antecedents of Inertia Towards Novel Technology

The structural separation of TechCorp R&D and CSUs allowed fundamentally different logics to co-exist at the organization, which translated into divergent appraisals of QKD as a novel technological proposition by the R&D department and CSUs. Operating under an exploratory logic, the R&D department interpreted the technology in terms of its ability to be a game-changing innovation, leading to positive appraisals of QKD being made. In contrast, the CSUs – who held the decision-making authority on new products and services and were guided by an exploitative logic – assessed QKD in terms of the total revenue it could contribute towards the organization. As a novel technology without an established market, these economic appraisals were not favourable, leading to the CSUs forming negative appraisals of QKD, causing them to reject the technology and contributing towards a state of inertia.

(a) Exploratory logic of R&D

TechCorp, like most multinational organizations, utilize a multi-divisional structure in which their R&D department is structurally separate from other autonomous CSUs aligned to a specific technological domain. R&D's primary responsibility is to explore nascent areas of science and technology outside of CSUs' current core business as well as to provide incremental improvements to support the continued exploitation of core business (Archival Documents - R&D Governance Document; R&D Innovation Process; R&D Innovation Continuum; R&D Scorecard; TechCorp R&D Webpage). While this suggests the R&D department balance both explorative and exploitative logics simultaneously, the former (exploration logic) was the sole responsibility of R&D and the latter (exploitation logic) burdened by CSUs, who provide R&D with explicit "business needs" to fulfil. As the Head of R&D told me, "I'm accountable to [executive] leadership, the board, for looking for innovation and technology that occurs outside of [TechCorp], that might be relevant to us and our customers." This focus on external technological developments occurring outside of TechCorp's status-quo manifested in a strong exploratory logic commonly held among all R&D employees:

> "About 70% of our research is what we would call 'core' and it's very much linked to what the business needs are… Other areas of our research are more long-term, maybe looking at things that are slightly to the side, slightly orthogonal to what the business thinks it needs, but actually we think they need to be aware of" (TM 3, R&D).

> "So, there's a real mix of some pretty well understood science and engineering applied to do things, right through to some really quite new stuff, where if they ever find the route to market, they're probably five to 10-years out… And you know, that's of an increasingly speculative nature to what you're doing and whether it'll deliver value, as you go down that time horizon, but also usually there's an increasing potential value. So, you know, if I'm working on something that the benefit is five to 10-years out, then you would hope it would be transformational in some way" (TM 5, R&D).

Indeed, the confidential corporate scorecard I was shown against which R&D's performance was evaluated emphasized the introduction of "new products and services that might give [TechCorp] a competitive advantage in the market" and "game changing innovations" as central metrics (Archival Documents - R&D Scorecard). Although some long-tenured members of the R&D department lamented the lack of truly blue-sky research they now completed, it was clear from my interactions with a variety of managers across the hierarchy that the purpose of R&D was to "deliver cutting-edge technology" (TM 1, R&D) and to disrupt existing ways of thinking. The notion of disrupting the status quo was echoed by several MMs, who reiterated their dominant exploratory logic:

> "The [R&D] team in the company are there to provoke a reaction. So often they are working against what the conventional wisdom is. You need that in a business, because if you don't [have it], you never go forwards. No one challenges the status-quo. So, they're there to agitate the business" (MM 1, R&D).

> "So, we actually challenge their thinking in some of the presentations as well. We'll ask them questions about 'well how would you use that, could that really benefit you? Have you thought about using it this way?'" (MM 3, R&D).

(b) Exploitative logic of CSUs

Distinct from the exploratory logic of the R&D department, TechCorp's CSUs all had a clear exploitative logic. CSUs were focused on "selling products that exist today" and "meeting market needs" across various product-market domains (TM 5, R&D) as to capitalize on TechCorp's existing capabilities and ensure the organization's competitiveness in the short-term. Each CSU was thus concerned with maintaining their own product-market domain by leveraging incremental improvements and step-wise innovations in internally existent products and services. As several informants stated:

> "CSUs are more customer-pull rather than technology-push: it's difficult to get seniors [top managers] within CSUs engaged with new technologies because they are focused on the portfolio of products and services they provide and the economic return that they will provide" (MM 2, CSU).

> "The more operational side has been well and truly separated out so that [R&D] are doing the more 'blue'—well actually I was going to say the more blue sky, but the research that a company like [TechCorp] does, they can't afford to invest too freely in research that isn't delivering out of a business purpose for CSUs" (TM 2, R&D).

> "You have to show that whatever money you are spending on research and funding [new projects] there's a clear end 'gain' and 'reason' for doing it" (OM 1, R&D).

Again, the dominant exploitative logic of CSUs was corroborated in confidential corporate scorecards that emphasized financial outcomes, such as return-on-assets (ROA) and return-on-investment (ROI), as the primary metrics of performance for CSUs (Archival Documents - CSU

Scorecard). As one long-tenured MM—who had held roles across several CSUs and the R&D department—told me:

> "The one thing that probably hasn't changed [in my time at TechCorp]—interestingly—is we're still driven by accountants. I mean a lot of people view us as a technology company, and we are, but ultimately, it's about being driven by the accountants" (MM 6, R&D).

(c) R&D's positive appraisal of novel technology

As a result of the variance in logics between the R&D department and CSUs, divergent appraisals emerged towards a highly novel technology— namely quantum key distribution (QKD). As part of their exploratory activities, R&D had identified QKD as a potentially transformative technology for TechCorp, given the likely emergence of large-scale quantum computing. By leveraging the principles of quantum mechanics, these proposed quantum computers would have the capability to decipher existing forms of encryption and thus render many of TechCorp's existing security products and services obsolete (Archival Documents – Quantum Technologies: Blackett Review).

Being externally oriented and driven by an exploratory logic, R&D's appraisals of QKD were unconstrained by existing business operations and focused on the possibilities of and excitement towards new technology. As one member of R&D put it, the R&D department were the "dreamers and thinkers of tomorrow" for TechCorp (OM 11, R&D). Thus, given the breakthrough nature of QKD that represented a complete departure from existing methods of securing communications through mathematical encryption to quantum mechanics, I found that QKD triggered strong positive appraisals of the technology amongst members of the R&D department, which were evident during interviews I had with several R&D informants, who stated when I asked about their early reactions to QKD:

> "[QKD], if it takes off, will completely revolutionize interconnectivity, not just from the customer to the business, but business-to-business, business-within-business… the revenue opportunities are **huge**, beyond belief" (OM 1, R&D).

> "[Satellite QKD] could be a real money spinner of its own. Totally separate from any fibre based QKD." (MM 5, R&D)

> "It is [QKD] the kind of capability we expect to [overhaul] the entire infrastructure [in the future]" (MM 3, R&D).

I found that members of the R&D team translated their positive appraisals of the technology into unsubstantiated revenue projections, which they articulated to the business as being "beyond belief" (OM 1, R&D). When I pressed OM 1 to elaborate on this revenue projection, alluded to in the quote above, they were unable to do so, responding: "well I don't have [the numbers]. David probably does, if not, Charlotte from all the talks and presentations. They'll certainly have them… it's worth asking them." Indeed, this optimism was reflected by others within the R&D team. As one MM put it:

> "Something like [QKD]… it's not immediately apparent there's going to be a billion-dollar industry tomorrow, but it is quite apparent there will be at least a multimillion-dollar industry a little down the line" (MM 1, R&D).

However, these appraisals were unsubstantiated, as document analysis indicated that the market for quantum secure communications was approximated at $70 million in total over the next five years by an external marketing company (Archival Documents - External Marketing Report on Quantum Enabling Photon Sources). QKD constituted only one element of this market, meaning that TechCorp could only expect a fraction of this figure. Nevertheless, these revenue figures were propagated by the R&D team in presentations that I attended (Observations - Event 1), who showcased the technology's "awesome" features for securing communications to the CSUs and communicated claims of the technology offering unprecedented financial opportunities (Observations - Events 1 & 3). Along with these presentations, the R&D team also developed a demo using prototype QKD technology to showcase its features and marked departure from the technology undergirding existing products and services.

(d) CSUs' negative appraisal of novel technology

Drawing on a dominant exploitative logic tied to existing products and services, the CSUs' appraisal of QKD were made through an economic lens that focused on its financial potential and ability to generate revenue in relation to their financial performance aspirations which were embedded within scorecard metrics, such as ROA and ROI (Archival Documents – CSU Scorecard). Consequently, TMs of CSUs were less concerned with the "awesome" features of QKD that R&D demonstrated, and more concerned with the unsubstantiated revenue projections and lack of clear financials required to arrive at a decision to support its pursuit. Indeed, most of the TMs and MMs I spoke with identified the lack of a clear market (customer) for QKD as a major factor inhibiting CSUs' support for the technology:

> "I spoke about how there are companies out there selling the technology right now, and so what you've got, you've got the potential to sell QKD technology today. Now we haven't—as a company—taken the decision to do that, and the main reason is because we are customer-driven, in terms of demand. If we don't see a customer demand on something, then we aren't going to spend time, effort, and money trying to support that" (MM 1, R&D).

> "What you really need is a customer, because in the end we need to try and make money. Despite my feelings, if customers say they want this and are going to pay for this, then I'm not going to cut my nose off to spite my face" (TM 2, CSU).

> "Quantum computers are always said to be 'five or ten years away' so people don't really recognize the threat." (MM 2, CSU)

Whilst R&D was described as being "the most patient money in the business" (TM 2, R&D), QKD was simply too distal a proposition to consider pursuing for the TMs of the CSUs. This was reiterated in meetings I attended where CSU MMs agreed that the technology was "five to 10-years

away", and this was an "optimistic" forecast at best (Observations - Events 1 & 3). Juxtaposed against objective performance aspirations, an internal report that was prepared by R&D stated that global demand for QKD would be less than 1,000 units (Archival Documents - Internal Use Cases for Project A). With such little commercial interest globally to satisfy the CSUs' revenue goals, the technology was unattractive to the CSUs, leading to it being rebuffed by the CSUs as interesting, but not (currently) valuable (Observations - Event 4).

Table 4.1 - Illustrative data for Aggregate Dimension 1: Structural-Behavioural Antecedents of Inertia

STRUCTURAL-BEHAVIOURAL ANTECEDENTS OF INERTIA	
Second-Order Theme	**Illustrative Examples**
Exploratory logic of R&D (a)	"About 70% of our research is what we would call 'core' and it's very much linked to what the business needs are. And often in those cases they can be very straightforward routes to downstream because we know we need this faster, and we need to make this do this differently. Although other areas of our research is more longer term, or maybe looking at things that are slightly to the side, slightly orthogonal to what the business thinks it needs, but actually we think they need to be aware of this as well, and those things can take much longer to downstream, if at all." (TM 3, R&D) "So there's a real mix of some pretty well understood science and engineering applied to do things, right through to some really quite new stuff ,where if they ever find the route to market, they're probably 5-10 years out. So the time horizon we operate in, I break it down as a third, a third, a third. The first third is really about now to about 18 months out, which is delivering value for customers in short order. Then there's a third which is about 18 months to 5 years, and then there's a third which is 5 years plus. And you know, that's of an increasingly speculative nature to what you're doing and whether it'll deliver value, as you go down that time horizon, but also usually there's an increasing potential value. So you know, if we're working on something that the benefit is five to ten years out, then you would hope it would be transformation in some way. It's working on an exam question that isn't a small tweak, it wouldn't have a minor implication for customers, it would be a major benefit in some way." (TM 5, R&D) "Everything along that incredibly rich track record is steeped in those three principles, of it's been science – the academic side of things – the engineering – the industry side of things – coming together to find innovation for purpose." (TM 1, R&D) TechCorp's R&D Scorecard 2019/20 has explicit targets for exploratory activities such as inventions and intellectual property rights, and discusses showing "leadership" through such activities, in order to be global market-leaders in their respective areas (Archival Documents - R&D Scorecards) Purpose of TechCorp's R&D department described as "finding better ways of doing things" by "running programmes to find new and exciting ways to use technology to generate revenue or cut costs" (Archival Documents - TechCorp Annual Report)

Exploitative logic of CSUs (b)	"CSUs are more customer-pull rather than technology-push. It's difficult to get seniors within CSUs engaged on new technologies because they are focused on the portfolio of products and services they provide and the economic return that they will provide." (OM 2, CSU) "Some things will just – it's interesting isn't it – somethings will just never go across the line, because the commercials around it just won't be there. It won't be supported for whatever reason" (MM 3, R&D) "The people in the CSUs role is both to sell products that exist today, meeting market need. And then the platforms that support them are there 24/7 delivering those products and supporting customers. So that's a machine that needs to work effectively, efficiently and against relentless pressure, to be honest. So if you try and innovate into that ecosystem there is always a little bit of a mismatch." (TM 5, R&D) Internal performance scorecards used to evaluate TechCorp's CSUs show that the scorecard places a heavy emphasis on financial performance metrics such as return on investment, return on assets, and particularly new revenue generation (Archival Documents – TechCorp CSU Scorecard) Falling revenues reported for various facets of CSUs, with management acknowledging need to improve on these performances and a promise to do so through focused activities in various sectors and regions (Archival Documents - TechCorp Annual Reports; TechCorp Strategic Reports)
R&D's positive appraisal of novel technology (c)	"QKD had its hype in the 70s and 80s, so only the good stuff survived. All the research has been done again, and we're starting to rise back up into the real world. Hopefully it won't have a second slump, which means any success we have today will be the real deal. We can sell it today." (OM 1, R&D) "Some [customers] do [understand] – some are highly enlightened customers knowing about the origin" (MM 4, R&D) "This is a no-brainer, they [banks] say 'yes absolutely, we would love it.' You can think of government agencies that would take a similar view on it as well." (TM 2, R&D) During meeting between R&D managers, CSU managers and OptiCo managers, acknowledged and accepted that QKD would not replace existing forms of classical encryption, but would behave as an extension, despite previous claims that it would revolutionise communications technology (Observations - Event 1) Members of R&D emphasising how QKD was something that was "difficult to get your head around" but continuing to suggest that it could have a huge, profound impact on communications (Observations - Events 1, 2 & 3) No mention of QKD (or any other forms of quantum-secured communications) in white paper released by the government on the cyber security of the nation's critical national infrastructure, despite there being frequent claims by R&D managers that the technology would be imperative to protecting the nation's CNI in the future (Archival Documents – Government National Strategy for Quantum Technologies; Committee Report on Quantum Technology; Observations - Events 1, 2, 3 & 4)

CSUs' negative appraisal of novel technology (d)	"They said 'well this is really flakey, I can't see how we're ever going to do this in a network that has to be robust. We've got lots of other ways of doing security. Nobody's asking for security in the optical layer at the moment.' So generally, there's no interest in it. Not really. They are just representing a very pragmatic view. And then they said – 'what you really need is a customer, because in the end we need to try and make money. Despite my feelings, if customers say they want this and are going to pay for this then I'm not going to cut my nose off to spite my face.' And they're right, we do need customers." (MM 5, R&D) "There is this kind of, thought in the business, that there's something to this and applications for this – it's worth keeping an eye on what's happening with satellites and all this stuff" (TM 2, R&D) "I think if someone turned up with a quantum computer and said 'here's me hacking your credit card from this SSL transaction in 10 seconds' – I think that'll have a very big impact." (TM 1, CSU) Threat of quantum computing described by TechCorp CSU managers as something that is considered to be "5 to 10 years away" and that was why it was not seen as a particularly urgent concern for that part of the business (Observations - Event 3) Market analysis for QKD carried out by independent marketing company indicating global demand of <1,000 units and negligible revenue for the technology. Predictions for future volumes also low until well into 2020s. (Archival Documents - External Marketing Report on Quantum Enabling Photon Sources)

INERTIA TOWARDS NOVEL TECHNOLOGY

(e) CSU inertia towards QKD

As a consequence of evaluating QKD through the lens of objective performance aspirations, the lack of demand that the CSUs saw in the technology meant that they exhibited an aversion towards pursing QKD as a novel technological proposition. Since novel technology is definitionally uncertain and an ex-ante market unknown, QKD constituted a "high-risk" (TM 1, CSU) proposition for CSUs with concrete financial targets and limited resources to achieve such targets, making it an unfeasible course of action for them to pursue. As several managers explained:

> "I think for a lot of them [CSUs] it's about being afraid of being number one. You know, the first one through—the pioneer. There's that old cliché that the definition of a pioneer is somebody lying face down in the mud with arrows in their back–it's not a particularly pretty image. And, as such, they're very wary about that, when their primary job is to sell products" (MM 6, R&D).

> "If QKD was something you could press one button and it was there, no problem. But you potentially have to alter infrastructure, you potentially have to put in a whole specific infrastructure for this capability, and it might only work on one part of the network. You have to do a lot of plumbing to make it work across your whole infrastructure. Essentially, would

you go to all that effort for what might be a small percentage of likelihood that you face this as an issue." (TM 1, CSU)

"Even now, they [CSUs] can't sell conventional optical security. So, if they're not selling anything that's doing conventional protection of optics, why would they want to sell a super-duper one [i.e. QKD]?" (MM 5, R&D).

Accordingly, when it came to deciding which innovations to "downstream" and introduce to the portfolio of technologies and solutions CSUs offered, TMs and MMs were inclined to only make commitments and sponsor projects aligned to objective performance aspirations, which resulted in a tendency towards incremental innovations at the expense of more novel, radical innovations like QKD. Although many CSU managers I spoke with conceded that this was problematic, they blamed "resource constraints" (MM 1, CSU) and "performance targets" (MM 2, CSU) as the reasons why it was difficult to pursue QKD and other novel technologies historically. Numerous R&D managers I spoke with lamented how the CSUs functioned on an 18-month time-frame, and that despite their best efforts to engage the CSUs about exciting new technological opportunities, these efforts often fell on deaf ears and were ignored. Informants from both the CSUs and R&D pointed to one CSU arm in particular who had a target to double their revenue in the following three years (Informal Discussions), which limited their interest to innovations that could deliver commercial value within that timeframe and contribute towards this outcome. As the decision-making authority regarding which technologies and services ought to be offered to TechCorp's customer sat with the CSUs, the lack of perceived customer demand couples with their financial performance aspirations led to a state of inertia, whereby the CSUs' aversion towards novel technologies like QKD led to myopic tendencies and the maintenance of the status quo.

Table 4.2 - Illustrative Data for Aggregate Dimension: Inertia Towards Novel Technology

INERTIA TOWARDS NOVEL TECHNOLOGY	
Second-Order Theme	**Illustrative Examples**
CSU inertia towards novel technology (e)	"I'm struggling to see anybody building their entire network with QKD protection." (MM 5, R&D) "It's been proven in the lab, the research stands up to tests, but it's a case of… you need a very clear, defined use case with volume projections…to go after that market." (MM 4, R&D) Members of TechCorp R&D department often referred to, or made comments about, the unwillingness/inability of CSUs to pursue more novel projects and courses of action as a consequence of their performance being based on financial performance measures that incremental courses of action were better able to help them achieve. Frequently told that it always came back to money. (Observations - Events 2-11) CSUs suffered from diminishing revenues in recent years according to Annual Reports, with management making promises in the same reports as well as at AGM to address

	this issue and ensure that their figures are on an upward trajectory in following years (Archival Documents - TechCorp Annual Reports; TechCorp AGM Documents & PowerPoints Slides) Conversations with informants from industry acknowledged that TechCorp struggled to innovate, recounting historical instances where they had missed out on significant innovations because of their incumbency and routines (Informal Discussions)

4.2 Phase 2: Emergence & Projection of Fear at TechCorp R&D

Emergence of R&D's Fear

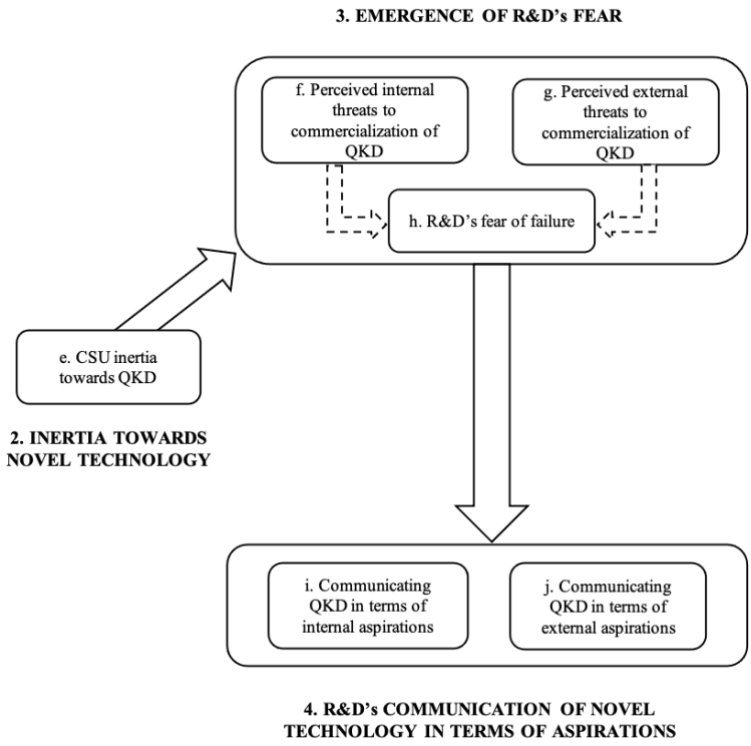


Figure 4.2 - Summary of Phase 2

Through their interaction with the CSUs, R&D were aware that unless they were able to demonstrate the financial viability of QKD aligned to the CSUs' objective performance aspirations, the likelihood of the CSUs opting to commercialize the technology was low. My analysis suggested that the lack of support for QKD among CSUs caused R&D's initial positive appraisal of the technology to turn into a shared experience of fear—fear of failing to meet a corporate scorecard target of introducing a "game changing innovation" to the business. I found that internal and external factors contributed to the emergence of fear among the R&D department, which I elaborate on below.

(f) Perceived internal threats to commercialization of QKD

I found that the negative reaction of CSUs towards QKD as a commercial proposition triggered a reassessment of the technology and environment among members of the R&D department. While some TMs were still convinced about the ground-breaking nature of QKD for TechCorp:

> "With QKD, I'm less concerned about that [cost] because I think that security and trust is becoming such an important commodity that if you can demonstrate that you're delivering that, I'm pretty confident that there's a sufficient premium in the market, that can cover the cost" (TM 5, R&D)

> "We are convinced that there is a place for QKD, that it will be required eventually." (TM 7, R&D)

> "We know that [quantum computing is] out there as a high likelihood event, whether it's 10 years away, 20 years away or just 5 years away, nobody really knows yet. However, if we can see that almost as an inevitability, then – and we also know that the ability to keep data secret is part of the basic fundamentals that the world runs on – so I see a new technology which enables that, we see a big opportunity and that's quite critical." (TM 4, R&D)

Other lower-level MMs and OMs started to develop severe doubts about the technology. Notably, some suggested that predictions of success were a "wet finger in the air" (MM 4, R&D), and others quipped that it would be "30-years plus" before QKD would actually eventuate (OM 3, R&D). Tellingly, one individual working closely on the technology reflected: "[QKD] is unlikely to revolutionize communications networks for a very long time" (MM 5, R&D). The initial positivity towards QKD seemed to diminish.

During meetings between R&D and the CSUs that I attended, it was evident that CSU support for the technology was low (Observations - Event 1). One CSU MM contributed that QKD was "running against trends" (MM 1, CSU) in their CSU, as customers were demanding software rather than hardware-based security solutions. They went on to explain that exploring QKD was a case of "finding the time" (MM 1, CSU), alluding to the resource constraints they were under, and implying that it was not a high priority item for them currently. This was problematic for R&D, who were aware that "if they're…promoting this cloud idea, then as soon as you come along with QKD – which is hardware and point-to-point – they just say 'that doesn't fit our strategy'" (OM 1, R&D) and would likely pass over the technology for potential commercialization.

At another meeting I attended (Observations - Event 3) that was organized between the CSUs and R&D to discuss QKD, the CSU MM who had been sent on a "discovery mission" (MM 2, CSU) by their superiors conveyed how CSU TMs could see the long-term implications of quantum computing, and QKD as a potential solution to this problem. However, they went on to explain that this meant they were unlikely to consider the technology commercially for at least another five years, at which point in time the quantum computing threat would be more apparent. The lack of imminent demand for the

technology meant it was not sufficiently attractive to truly pique the CSUs' support or interest. Again, this was perceived by R&D managers as a threat to the commercialization of QKD.

Based on these observations and interactions with various members of R&D, it seemed the positive appraisal of QKD was re-examined on the basis of the lack of internal support for QKD among CSUs (Informal Discussions). Members of the R&D department were very aware that "internally, [we] needed one of the businesses to go 'yep, I want that in my portfolio.'" (MM 4, R&D) to successfully commercialize the technology. The problem was that this didn't seem to be the case:

> "QKD is not on safe ground [from a customer perspective]. Quantum is nobody's. It's totally out there [radical]. I mean most people in TechCorp don't know how to spell [QKD], so it's very, very uncomfortable [for CSUs]" (MM 5, R&D).

Without CSU support, any attempts to commercialize QKD would be challenging, and as one CSU TM explained: "the more pilots and success stories that come out of quantum computing, the more action people are going to take [on QKD]" (TM 1, CSU). As the threat of quantum computing crystallized, the need for quantum security became more ostensive, and would likely drive demand for the technology. Currently, the lack of demand translated into a lack of CSU support, which was reiterated by another R&D MM, who explained:

> "We have warnings around it [QKD], the biggest is we don't have any customers crying out for it. So, in the end, if we had customers, everyone would forget about any of these issues and cash in, but we can't. It's not being sold, and it's not obvious. It would make a huge difference [in terms of CSU support] if we had people going 'I need that in my network." (MM 5, R&D)

Since the successful commercialization of QKD – i.e. the introduction of the technology into the CSUs' portfolio of products and services they offered – fundamentally depended on the CSUs supporting the technology, this lack of support was perceived as a threat by the R&D department.

(g) Perceived external threats to commercialization of QKD

In an attempt to vindicate their initial positive appraisals of QKD as a potentially revolutionary technology, the R&D department sought to garner evidence of early external market support (Observations - Events 8-12). As one MM described: "what you want to see in an innovation is someone making a 'big bet' on something, and someone putting a lot of money into it" (MM 1, R&D). The sentiment was that if other organizations were willing to "just go and do [QKD]" (MM 5, R&D) in spite of the uncertainty, this would be an impetus for CSU adoption within TechCorp.

Early indications, however, were not positive, as QKD did not appear to be commercially supported by industry. Rather, those pursuing QKD seemed to be largely propped up by government, who had invested billions of dollars in early-stage research and development of the technology in an attempt to drive a quantum revolution (Observations - Events 2 & 15; Archival Documents -

Government Quantum Technology Roadmap; Government Quantum Technology Programme Annual Reports). Publicly available government documents detailed how QKD was seen as a critical enabler to the "data revolution," and with the implications of Brexit for the economy remaining unclear, the need to stay at the forefront of quantum was considered to be crucial by government, as the likes of the United States and China, amongst many others, invested heavily in the area (Archival Documents - Government's Industrial Strategy). The extent of government support led one informant to comment: "it seems [QKD] is more like part of a government-sponsored exercise [rather] than a truly healthy, commercial activity moving towards a new product" (OM 10, R&D).

A meeting I attended organized by the R&D department with their counterparts in a number of other, global technology firms to discuss and share general experiences of QKD corroborated this insight (Observations - Event 2). Unanimous concerns were raised in the meeting about QKD's economic viability, with all attendees reporting little interest from potential customers in their respective markets for QKD as a product/service. Indeed, vendors were said to be exploring post-quantum cryptographic solutions should a quantum computer emerge as an alternative to QKD, which were complementary to existing infrastructure rather than disruptive. After the meeting, I asked members of R&D who attended whether this could be purposeful competitive misdirection to detract TechCorp interest. They explained that this was unlikely as the market was still "pre-competitive" (OM 4, R&D; MM 5, R&D), an insight verified in interviews with a number of other external sources (TM 1, QKD Co; TM 1 & TM 2, Quantum Solutions; TM 1, Government). Further investigation (Archival Documents – News & Media Articles; EU Commission on Quantum Technology; Quantum Technology Roadmap: European Community View) revealed that only four out of the twelve participating organizations were actively researching QKD at the time.

Customer support was also low, with one member of R&D describing how during a technology demonstration to a prospective customer "the customer came up and said 'yeah, so what? It's an expensive student project, isn't it? Why would we do it?'" (OM 10, R&D). This issue proved to be persistent, as other prospective triallists showed no urgency in committing to trials (Observations - Events 12, 16 & 18), voicing concerns about the "traceability of the supply chain" (MM 5, R&D). One customer in particular became a "dead-end" (OM 5, R&D in Event 20) despite having shown significant interest and enthusiasm in workshops to discuss a potential trial just a number of weeks before (Observations - Event 10). More tellingly, the R&D department were left to rue the lack of customer support when they failed to attract **any** customers whatsoever to an industrial event they held to celebrate pioneering work that demonstrated how QKD could be delivered through extant fibre networks, using commercially available equipment (Observations - Events 13 & 15). Ultimately, without customer support, it was unlikely that there would be a change in position on behalf of the CSUs, and commercialization therefore remained a distant prospect. Thus, the lack of support from

both industry and customers were perceived as threats to the commercialization of QKD that were external to the organization.

(h) R&D's fear of failure

As R&D managers began to perceive the lack of support for QKD, both externally by customers and industry, as well as internally with the CSUs, they began to experience a fear of failure. Existential questions over the need for R&D at TechCorp already existed, with some CSUs suggesting that they had historically failed to deliver sufficient value in the form of "game-changing innovation" to warrant their continued investment (MM 5, R&D; OM 4, R&D; OM 6, R&D). During informal conversations with TMs and MMs from R&D, many explained how they felt "under threat" and feared the consequences of not reaching their organizational goals around innovation. I was told how the department "still [had] strong memories of being punished for failure" (TM 4, R&D). In this manner, one informant told me that R&D "***need*** to be able to show big, thought leadership. Disruptive thought leadership, to the point where we have a big impact regularly…every two years, R&D needs a big win" (MM 5, R&D) in order to ameliorate question marks over their funding and existence. However, as they went on to explain, R&D had failed to demonstrate such an impact in recent times and needed to provide a reminder of their value:

> "The last big thing that [Brian – Head of R&D] would say R&D did was something called C-Speed, a copper technology. We could all argue if that's true or not, but Brian claims it as an R&D win. So, if R&D wasn't here, that wouldn't have happened. I sense he's always having to justify himself to [CSUs] who say 'what's R&D ever done for me?' And we need to be able to say 'we've done this, we've done this.' Brian is also quoted as saying 'I need a big thing every three or four years, otherwise all of these other little things—of which there's millions—they pale into insignificance. I need to be able to say I've done something big'" (MM 5, R&D).

R&D managers worried that failing to deliver QKD – a game-changing innovation – might result in their budgets being slashed, or the department potentially being divested (Informal Discussions). While the perceived lack of internal and external support for the technology was the initial basis for R&D's fear of failure because it would prevent them from fulfilling their organizational goals around innovation, this fear was further exacerbated by movement in the market by OptiCo, a long-standing collaborator of TechCorp's. OptiCo were described as being "conservative with a capital C, you don't get more conservative" (MM 5, R&D) and the fact that they were close to "taking a punt" (MM 5, R&D) created concern. If OptiCo, who were generally conservative and risk-averse in their strategic decision-making, were sufficiently convinced to make a commitment to QKD, then TechCorp were likely to be a laggard. This was significant because not being amongst the first, or first few, organizations to market would likely reduce the financial attractiveness of the market opportunity, especially if it was perhaps more limited than they had previously asserted (Informal Discussions). R&D managers knew this was likely to further hamper their ability to convince the CSUs to pursue

QKD, given their exploitative logic. In this respect, the successful commercialization of QKD was described as being "a bit of an arms race" (TM 2, R&D; Archival Documents: News & Media Reports), and one that TechCorp might fail to capitalize on, despite being responsible for a significant amount of proprietary development.

In an attempt to avert this outcome, R&D TMs declared QKD as a "big bet" innovation (i.e. goal) for the department (Informal Discussions; Observations – Events 4 & 5). They hoped that by focusing energy and resource on the project, they might be able to overcome the perceived obstacles to its commercialization. However, this also intensified the pressure and fear of failure amongst MMs and OMs. MMs and OMs that I spoke with described how "the pressure has increased [to deliver QKD as a commercial capability]. Pressure has increased and they've [TMs] started to send out emails [to push the QKD agenda]" (OM 1, R&D). Others told me that there was "lots of pressure on the team [working on QKD] to make progress" (MM 5, R&D) from TMs. Poignantly, the Head of R&D was said to have "bet their career on [QKD]" (OM 6, R&D), which exerted even further pressure on MMs and OMs. The Head of R&D was well-respected and liked amongst managers, and there was a collective fear that failing to deliver QKD may have consequences for their career. As a result, MMs and OMs felt that they "had [the Head of R&D's] fate in their hands" (OM 6, R&D), which exaggerated their fear of failure again (Informal Discussions). One MM was particularly exasperated, commenting on their inability to address a major threat to QKD's commercialization in the lack of customer demand:

> "I can't fix this [lack of customer]. I can't magic a customer. I've been trying for ages. I've spent many, many hours visiting banks and stuff around the country, and talking about QKD on every platform I can possibly get. I think I've done all I can do from my position to generate a customer. There isn't one yet." (MM 5, R&D)

I was present when news of QKD becoming a 'big bet' was announced to members of the R&D department who were principally working on the project (Observations – Event 8). There were (facial) expressions consistent with surprise and fear amongst the managers present, many of whom exhibited opened mouths, taut faces, raised eyebrows and wide eyes (Ekman & Friesen, 1978; Matsumoto, Keltner, Shiota, O'Sullivan and Frank, 2008, Chapter 13). Managers exclaimed "we can't do that!" (OM 12, R&D in Event 8), indicating their perceived low capacity to cope with this challenge. When I followed up with members of this group throughout the rest of that day, they told me that they didn't believe it was possible to fulfil the goal of delivering commercial QKD capabilities inside two-years, given the work that still needed to be done (i.e. uncertain ability to manage or cope with threat). Many also disclosed apprehensions about the consequences of failing in this task (i.e. existence of threat or danger), ranging from damage to social esteem and reputation within the department, to potential job loss (Informal Discussions). The description of situations in which undesirable things might happen to them, coupled with uncertainty over outcomes and low to moderate levels of perceived control, suggested that these managers were describing experiences of fear, which was congruent with the aforementioned facial expressions I observed.

Over the subsequent weeks and months, this fear of failure held by managers in the R&D department seemed to become increasingly intense, and more evident in interviews, informal discussions and observations I conducted. Managers described how they felt fear, scared, anxious, nervous and worried, and some even described physical manifestations of fear. For example, one informant opened an interview with "I am feeling more worried now [about QKD] than when we last spoke" (OM 5, R&D), whilst another told me that the involvement of new personnel in the efforts to deliver QKD "scares me" (OM 4, R&D). Although appreciative for the additional manpower, they felt that their lack of understanding impeded their ability to explain the technology to management and customers, and that this would hamper the efforts to build the necessary internal and external support and understanding for QKD in order to facilitate its commercialization. On a separate occasion, they described how news that they were presenting the technology to critical TMs in the CSUs "made [them] shudder" physically, going on to assert: "I'm terrified they're [presenting on] it. It terrifies me" (OM 4, R&D). Again, they feared that their lack of understanding might result in messages being incorrectly communicated, which could have implications for the project's commercial success.

Managers also began to routinely voice their concerns and apprehensions about meeting the two-year goal that had been set for them in team meetings that I observed (Observations - Events 11-14, 19, 25). During discussions about an upcoming demonstration of QKD at a major industrial event, managers described their fear that the technology would fail to work (Observations - Events 11-14) and what the implications would be for fulfilling the 'Big Bet.' When a technical bug began to affect the demonstration, discussions on how to resolve this issue (Observations - Event 13) resulted in exclamations of "**don't** touch it!" (MM 5, R&D) because it was "too risky!" (OM 11, R&D) to do anything. The managers responsible for these quotes later explained how they feared that trying to adjust the technology may render it non-functional for the event itself, which would have catastrophic consequences for the project (Informal Discussions). Ultimately, it was concluded that an alternative demonstration would be prepared that gave the appearance of using QKD for the distribution of encrypted keys, but would in fact rely on conventional techniques (Observations - Event 14). Despite R&D managers' fear that the technology might fail to work, "the show [had to] go on" (OM 11, R&D) given the prominence of the event. At this industrial event, the R&D managers looked particularly stressed (Observations - Event 15), and afterwards spoke of their relief that the technology did not fail during the event itself, which they had feared happening (Informal Discussions).

A lack of progress in terms of developing customer interest in the technology also contributed to R&D's fear of failure. One manager told me how they had a "fear of the next [collaborative project] meeting" (OM 4, R&D) because they had made so little progress in recruiting potential customers for the technology. When questioned further, the informant explained that without a customer the project couldn't progress. As I asked what the consequence would be if this continued to be the case, they paused, then responded, "we're absolutely f***** if that happens" (OM 4, R&D), going on to explain

that the project would likely be curtailed, and that this would likely result in QKD being wound up at TechCorp as well, given the project received significant funding from such projects. This persistent lack of customer interest continued to stymy the progress of the QKD project, ultimately leading to the project falling behind schedule and receiving "a red status" (OM 1, R&D), which again heightened managers' fear that failure might occur (Informal Discussions). Discussions with other global technology organizations did little to allay R&D's fears, reporting that they had had no more success with customers than TechCorp (Observations - Event 34). R&D managers knew this was a significant threat, because TechCorp was "run by accountants" (MM 3, R&D, MM 6, R&D; OM 6, R&D; OM 7, R&D; Observations - Event 8) and therefore to facilitate the downstreaming of any technology irrespective of novelty, it was paramount to show "a clear path to profit" (OM 7, R&D) to articulate how it was a clear and viable opportunity. Without customers for QKD, this path to profit did not exist, and it would be impossible to deliver the technology successfully. In light of these circumstances, one MM reflected:

> "Unless they [the CSUs] see the immediate threat or profit, they're not going to do much about it. You need to build that burning platform." (MM 6, R&D)

Table 4.3 - Illustrative Data for Aggregate Dimension 3: Emergence of R&D's Fear

EMERGENCE OF R&D'S FEAR	
Second-Order Theme	**Illustrative Examples**
Perceived internal threats to commercialization of QKD (f)	""It's quite difficult – it's not impossible – but it's quite difficult to do anything of significance inside the organisation without some sponsorship from the customer side. And you know, so if you don't have buy-in, then chances are your technology idea doesn't get very far." (TM 1, CSU) "What would be more worrying politically would be if, depending on whether the technical demo works, would be if it fails to have impact and people say 'so what? What's it for?'" (OM 5, R&D) "But because at the moment it's just a lab test, and as far as the account team's concerned, it's not something that they can sell yet or in the near term, then it's not something that's going to be top of their list to talk to their customers about." (MM 6, R&D) Techno-economic analysis carried out for Project A described QKD to be *"very niche"* in 2020 with only 10 units predicted to be sold – it would remain niche until the mid 2020s, beginning to gain traction in 2024 until 2028. Unit sold per year not anticipated to exceed 1,000 until 2025. Pricing also remains very high - $160,000 per system – only coming down to $80,000 by 2026. Given assertions that QKD might not be interesting until at the $15,000 mark by other individuals on the team, indicative that QKD remained financially unattractive. (Archival Documents – Project A: Techno-Economic Analysis; Project A: Use Case Report)

Perceived external threats to commercialization of QKD (g)	"We wouldn't want to see military or government being the early adopter, because there's already a solution to the problem it simply doesn't make sense to be the adopter. I think the banks often feel this way as well – every bank will want to be standards compliant, more for perceptual matters really, they win or lose custom based on how they're perceived. And they get prosecuted or don't depending on whether they're standards compliant. So, each of those is more or less happy to be the second adopter, you know when they see the first adopter, then sure, why not. But no one wants to be first adopter. There needs to be more market research if you're going to think about how this is going to progress to market. And, if I was an investor, I'd see this as a long-term prospect rather than a quick one." (Security Consultant) "The use cases are so important, it's the crux of everything for the next few years, if it doesn't kick off now, it probably won't. I don't think it will, it's now or never. MiningCo aren't going to fund quantum research forever, are they? It's one of Brian's Big Bets, isn't it? After two years if we've not got much to show, I think it will get cut. It dawned on me that's probably what they were saying. You've got to prove yourself, otherwise it's going to be highlighted." (OM 4, R&D) "With this one it's not happening, because I don't think anyone is 100% convinced. Even the vendors aren't projecting huge numbers of sales of units of these things. If you sell it to government and critical national infrastructure then yeah, ok, it's good, it's important, but you aren't talking about thousands of units of these things. You might be talking about a few hundreds, or maybe a thousand, in the UK at least. In the US or some bigger country it might be different. But, you're certainly not talking about massive quantities of these things being sold – and until you are, this is a bit of a niche technology, very important, but niche, and therefore it's never going to make the business a tonne of money. So how much enthusiasm should we be willing to put into it?" (MM 1, R&D) Customer engagement identified as a critical task to carry out over the next 12 months by R&D managers, to help stimulate customer demand. Managers working on QKD project highlighted how they are still trying to clarify the use cases because despite years of work, they still remained very uncertain and unclear (Observations - Events 11 & 12) Significant levels of collaboration taking place between industrial and academic organizations, but only in terms of government-funded collaborative projects. Globally, only a few major organizations making significant investments and commitments into QKD (Observations - Events 14, 15, 18 & 19; Archival Documents - Government Quantum Technology Roadmap; Government Quantum Technology Programme Annual Report; News & Media Reports) Progress being made in field of quantum-safe algorithms, the alternative to QKD. First round of a global competition run in the USA by NIST came to a close. Alternatives to QKD slowly beginning to emerge, with government security bodies in the USA and UK in particular voicing a preference for post-quantum algorithms over QKD (Archival Documents – News & Media Reports)

R&D's fear of failure (h)	"They [the TMs] do listen however to [MM], who has been extremely positive. [MM has] done everything they can to move [QKD] forward. To a worrying extent. I've seen senior people like [name] and [name], and even [the CEO] starting to get overexcited about QKD. It feels like we can't fail" (OM 11, R&D) "It does always scare me that people don't know what they're talking about [with QKD]…and they're the ones talking to customers" (OM 4, R&D) "I think that there's a degree of apprehension, anxiety and nervousness for the groups in question [about whether QKD will succeed or fail]" (TM 1, R&D) "We're f***** [if no customers show demand for the technology]. If literally no one is remotely interested then they'd have to cut the funding and the research because what's the point?" (OM 4, R&D) Uncertainty over investments made by other global technology organizations into equipment manufacturers led to the team voicing apprehensions and concerns about being "*in the dark*" with respect to where they were in comparison to other global technology firms. Talk of potentially missing the "*big tidal wave"* if TechCorp did not start to act soon, and financial attractiveness diminishing if weren't amongst first few to provide it commercially. (Observations - Events 20, 22 & 23) Discussions between R&D managers reveal worry regarding progress being made on R&D goal of commercializing QKD, particularly when it received an amber and then red status for being behind. Managers described how they were "worried because [they] see the potential dangers" and were "worr[ied about] the market size." Offline conversations revealed how some members were "getting nervous because [they] think it'll fail" (Observations - Events 26 & 27; Informal Discussions) R&D personnel describing the *"increasing scrutiny"* they were finding themselves under as a direct consequence of QKD being announced as an R&D goal, and being behind on where it was meant to be. R&D MMs also pointing to noticeably higher levels of engagement from R&D TMs, who had begun to send out more emails and organize more meetings with regards to the QKD. Responsibilities and milestones given out, which had not been defined until this point in time, suggesting increasing levels of pressure from corporate management for tangible developments being made on project (Events 12-14 & 16-18) News of investments and developments being made by/in QKD companies and manufacturers including Red Technology, OptiCo and Delta Technologies contributing to fear of failure, owing to lessened financial attractiveness of commercial proposition if market is already full or saturated (Archival Documents – News & Media Reports)

R&D's Communication of Novel Technology In Terms of Aspirations

The emergence of fear within the R&D department seemed to produce a series of interactions with the CSUs, through which they sought to re-frame QKD as a prospective internal and external aspiration for TechCorp. Following these interactions, I identified the emergence of dual fears of failure and missing out, which appeared to cause the CSUs to become ambivalent towards QKD. In framing QKD as an internal aspiration, the R&D department had prospected the technology with a series of

potential customer groups and gathered highly speculative sales figures to present to CSUs that aligned with their objective performance aspirations, as well as push the technology as an organizational aspiration. Further, during re-framing QKD as an external aspiration, the R&D department positioned QKD in terms of national aspirations which emphasized the technology as important for the country and its global competitiveness. Collectively, these framing interactions appeared to soften the CSUs' initial rejection toward the technology, making them more palatable to its potential pursuit.

(i) Communicating QKD in terms of internal aspirations

To stimulate interest in QKD as a commercial proposition and attempt to align the technology to the CSUs' objective performance aspirations, the R&D department "prospected" (OM 4, R&D) the technology with potential customer segments to garner interest. A range of industries were targeted that would value the 100 percent security and overall "trust" offered by QKD in their communications (OM 6, R&D), which included finance, healthcare, pharmaceuticals, defence, and high technology among others. While no QKD product or service yet existed for R&D to commercialize and several questions remained unanswered regarding the technology's "range [distance] limitations" for securing communications and its satellite capabilities for non-wired networks (MM 4, R&D), prospective customers valued the possibility of absolute security (Observations - Events, 31, 36, 38 & 40). This "prospecting" allowed R&D to generate highly speculative "if—then [if QKD achieves range and satellite capabilities then there is X market]" market sales figures across various industries.

I was shown a PowerPoint presentation that was to be presented to the CSUs at the next R&D review meeting, which contained figures ascertained from R&D's prospecting activities, along with figures derived from R&D's internal market analysis and efforts to collect external market reports (Archival Documents - R&D Techno-Economic Analysis). These "glitzy slides" (MM 5, R&D) graphically illustrated the potential sales figures for QKD across various industries, and framed the technology as a financially attractive – albeit speculative – early-stage innovation, with the potential to become a $5 billion global industry and $400 million market for TechCorp. In this manner, R&D aligned QKD with the CSUs' objective performance aspirations, encouraging them to invest.

However, when asked about these figures, R&D personnel acknowledged that they were in themselves speculative. For example, the estimate of QKD as a $5 billion industry was derived from external market reports that the organization did not buy, because they were in the region of $10,000 each. As such, members of R&D that I spoke with admitted that they could not confirm the intricacies or assumptions that these figures were based upon, going on to explain that there were in fact other reports that suggested the QKD-specific market would be "an order of magnitude" (OM 6, R&D) smaller than this $4-5bn figure. The internal analytics carried out by R&D – which accounted for the cost of infrastructure – corroborated that QKD was not a lucrative $4-5 billion industry, indicating that when considering infrastructure costs and the pay-back period of over a decade, QKD would perhaps be worth a few hundred thousand to TechCorp (Archival Documents – R&D Techno-Economic

Report). Nevertheless, R&D were aware that the figures they presented needed to be significant enough to attract CSU interest, explaining that:

> "Most of the modelling is a tool to win the hearts and minds, to make people decide they're going to do it. Most of this stuff is very difficult to justify, especially being infrastructure, it's very difficult to justify on any 3, 5, 8-year payback. Very little infrastructure pays back on that. You would never do it if you did it on a traditional PWC, you'd never do anything if you did that." (OM 10, R&D)

Further, having recognized that customers valued the guarantee of absolute security, the R&D department began to pitch QKD as a way of becoming "seen as the provider of choice for trust and security" (OM 1, R&D). In doing so, they were able to frame the technology to the CSUs as a subjective organizational aspiration that was aligned with their performance targets, as well as one of TechCorp's corporate goals: to re-establish the company as "systemically important" (TM 5, R&D) to the nation. As one informant explained to me:

> "The thing about that is being the provider who's a 'provider of trust', and has the trust from being a long-life brand, but also is seen to go out of its way to invoke the security of its customers, whether home or domestic… No one is going to buy QKD from a provider they don't trust. So that's another important point. Take for example—they're too small to do it—but CommunicateCo. A massive data breach, however many years ago it was. They're going around the town centre and people are giggling at them in the street when they're trying to stand there and hand out pamphlets because the trust in them was gone. No one wanted to use CommunicateCo. If they came out and said they had a QKD service, no one would use it because the trust isn't there. For TechCorp, we've got all that history and reputation. The trust is there" (OM 1, R&D).

Conversations I had with various members of R&D revealed that the reaction of TMs towards the presented case for QKD had been overwhelmingly positive, and that R&D had been given the green light to "plough on" (TM 4, CSU) with commercializing the technology, which was a massive feather in the cap for the department (Observations - Event 40). Understandably, the company CEO was particularly excited by the technology, appreciating how effective it could in differentiating TechCorp from their competitors and re-establishing the company as critical to the country in the eyes of the public. During a visit to the R&D facilities, team members reported that the CEO had subsequently been very direct in their request, asking them "to get on and do it [QKD]."

(j) Communicating QKD in terms of external aspirations

Along with efforts to frame QKD in terms of internal objective aspirations and subjective organizational aspirations, the R&D department also started proactively framing the technology in terms of external, national aspirations. It was a well-known fact that the government wanted to become the "go-to place" (TM 2, Government) for quantum technologies, with many billions of investment being made, a fact I verified through interviews and informal discussions with senior officials from government, as well as publicly available documents (Informal Discussions; Archival Documents –

Government Committee Report on Quantum Technology; Government Quantum Technology Roadmap; Blackett Review; News & Media Reports). TechCorp had been a recipient of considerable government funding, to the point that QKD thus far was in fact cost-neutral for the business. In part, these national aspirations were driven by the significant photonics sector that already existed that could underlie quantum applications. However, more significantly, the government were concerned with state-sponsored attacks on their critical national infrastructures that necessitated the need for secure communications capabilities (MM 5, R&D; OM 4, R&D; MM 1, R&D). With significant investments being made in countries such as the United States, China, Australia, Russia and within Continental Europe (Archival Documents – News & Media Reports), QKD had become seen as a potentially critical national capability and thus a "national endeavour" (MM 2, R&D), an insight that was substantiated through interviews with various government officials:

> "So, think of this as critical national infrastructure, a critical national capability. Secure comms is in that domain. It is a competition and a race, but it's also one of those things that if you can't be first, you have to be a close second" (TM 2, Government).

> "These are programmes to put us at the forefront of artificial intelligence and the data revolution" (TM 1, Government).

Piggybacking on the national need for secure communications capabilities, the R&D department framed QKD as a way in which TechCorp could become the provider of trust to the nation. R&D knew that becoming the national provider of trust was a unique differentiation strategy that few – if any – other organizations could pursue. As one R&D member explained:

> "The message we're trying to get across is that we are a [national] business and a systemically important one, which is fundamental to the wellbeing of the nation. And of course, in that context, that does position you really well to have bold ideas like becoming the purveyor—well, being the purveyor of trust—for the nation. And in that sense, QKD as something that is a 'credentializer' fits really well" (TM 5, R&D).

R&D also argued that the pro-QKD position assumed by government was evidence that tangible demand for the technology existed, as a way of appealing to – and further aligning the technology with – the CSUs' financial performance aspirations. At an industrial event I had attended, this had been iterated by a government representative, who directly addressed the size of the QKD market (Observations - Event 15). They continued to suggest that whilst many expected it would only be a "niche" technology, they [government] envisioned it developing akin to the photonics industry, which although less conspicuous than the prominent industry of pharmaceuticals, was worth considerably more (TM 3, Government).

As other organizations continued to develop their QKD propositions ready for market (Observations - Events 30, 33, 34), competitive time pressure to move on QKD was mounting, leading R&D to emphasize the need for TechCorp to act now. Not only was there a financial market opportunity

at stake – implying a threat to the CSUs financial performance aspirations – but as hacking capabilities developed globally, there was a pressing need for national secure communications capabilities. R&D cited that amongst government officials, the prevailing expectation was that TechCorp would be a "major delivery arm… in terms of rolling out quantum-secure communications" (TM 4, Government) and if they opted not to act, there was a risk that they would let the nation down. Framing the pursuit of QKD in terms of external, national aspirations was particularly powerful: not only did it reinforce the internal, subjective aspiration to become the national provider of trust and aligned this with the CSUs' objective performance aspirations, but the notion of becoming the national provider of trust resonated with the desires espoused by TechCorp's top management to re-establish the company as a "national treasure" (TM 5, R&D), making it clear that inaction would be detrimental to this outcome.

Table 4.4 - Illustrative Data for Aggregate Dimension 4: R&D's Communication of Novel Technology in terms of Aspirations

R&D'S COMMUNICATION OF NOVEL TECHNOLOGY IN TERMS OF ASPIRATIONS	
Second-Order Theme	**Illustrative Examples**
Communicating R&D in terms of internal aspirations (i)	"I think it's this relaunch of TechCorp. It's the Brexit impact on national security. The national dialogue – it means much more than it did. So that helps. And it's TechCorp's ambition to be a part of that narrative, that Security narrative. QKD fits very, very well. It means we don't have to pin it all on QKD, so we want to be the 'provider of trust' – beautiful phrase – 'we want to be the custodians of national security' because we can be trusted, because we're big enough." (MM 5, R&D) "Corporately here I think we would like to position it as disruptive…not necessarily as disruptive, but as a clear differentiator, because I think TechCorp needs to be seen as being a leader, as being first to market, and as having a security capability that it more secure than our competitors" (MM 4, R&D) "I think they're [CEO] excited by it. And I think they're excited by the idea of us being a provider of trust. So, there's that sort of broader lens around whether or not they see resonance between that aspiration and the brand of TechCorp, and the way that TechCorp sits in the ecosystem. I think they see a real resonance there, which is good. It means I'm pitching into a winning audience, is how I'd put it!" (TM 5, R&D) "Provider of trust sounds awesome, doesn't it? QKD doesn't sound quite as good. Some of it is marketing. Providers of trust is something that people can repeat and if you hear it enough times then you'll probably find yourself repeating it as well. It's really good. What it's trying to do is talk to the fact that the way we think that QKD will start – which will be point-to-point services – isn't really where the end game is. The end game is – kinda like RSA you know, people might know RSA because of the story and all that kind of stuff. People who do banking, online shopping, anything online e-commerce, people who are doing that don't necessarily appreciate that RSA and TLS and things that make that possible, safely, exist. I think that's what [name] is trying to do with 'providers of trust.' It will go to the point where QKD just happens to be the way that it happens, or whatever the next algorithm that comes up to replace RSA is. To try and move the discussion on beyond point-to-point services. That this could be pervasive, it could be everywhere. It just happens to be QKD that's doing it, and that

	speaks to the more significant revenue opportunity. It's never going to be – and this may be where some of [name] peers would like it to be – QKD as the replacement for RSA. The dollar signs would be rolling." (OM 8, R&D) Circulation of documents and slide-decks within TechCorp, in which the pursuit of QKD was positioned as an endeavour that would allow the company to differentiate themselves and become *"providers of trust,"* helping to give the organization the image and reputation for being a leader in security services within their home and global market (Observations - Events 30, 33 & 34). Discussions during weekly team meetings that the pursuit of QKD was attached to the vision of becoming providers of trust, as this was a way in which the 'end-game' that QKD facilitated could be opened up to the account managers, etc. in the CSUs and seem like a more attractive opportunity, even if it would not necessarily deliver financial returns immediately (Observations - Events 35, 39, 40, 41) Slide deck circulated amongst R&D managers regarding "10 Year Vision" for QKD, and meeting held to build concepts (Observations - Events 48 & 49)
Communicating R&D in terms of external aspirations (j)	"But if you say 'go-to place', what you want is that when that person goes 'oh where should I place my new factory in quantum?' the association is there. Now, it's never going to be the only place, but you want this to be at least in the top few, at least in the top end. And that's what we mean by the 'go to place.' If an academic is finishing their PhD in some form of quantum tech area, and you go 'where should I go to do my PhD? Ah I want to go to the UK, that's where the universities are that will give me a really good PhD, that's where the jobs are, that's where the academic positions are.' So, it's trying to get that association, because it's real." (TM 2, Government) "Quantum is special in the way that what we are seeing is an emerging technology, a potential threat, that comes about as a result of [quantum computing] actually happening or not. So, it's a bit dependent like that. It's sort of running counter to the way we'd think about it, because if you think about how to protect against quantum computers. And the ecosystem isn't really there. So, we've got lots of little complex things going on. It shouldn't be underestimated, what has become a national endeavour, it's such a complex thing, if we pull this off, it'll be a huge success for the country." (MM 2, R&D) "The UK is now also officially a supplier to the rest of the world – so you don't want just one outfit that makes chips, you want several outfits that make chips. People often speak about the optical-electronics sector, and that there are 15,000 companies currently operate in the photonics sector. Clearly it's going to be a while before you have 15,000 in quantum, but there is clearly an ambition to have a concept of value chain players, and all the possible capability, manufacturing capability, service capability in the UK." (TM 2, Government) High levels of scrutiny shown by monitoring officer at review meeting for government-funded Project A that TechCorp were involved in. Monitoring officer making it clear that this was a *"high profile"* and important project for the government, and therefore there was an expectation for progress given the considerable sums invested. Asked questions pertaining to intricacies of how TechCorp were carrying out work to develop use cases (e.g. what were they discussing during deep-dive workshops), why they had

	been slowed down, what contingencies were in place, and whether their delay would impact the rest of the project's key milestones. (Observations - Event 21) Discussions of the desire for *"sovereign"* capabilities in light of the work being carried out around the world, and the potential threat that might be represented by state actors like Russia and China. (Observations - Events 31, 33 & 45) Government documents detailing opportunity presented by Quantum Technologies, with a roadmap for potential applications and how these outcomes may eventuate. Accentuated that the UK was at the *"forefront"* and that they hoped to continue to capitalize on their *"comparative advantage."* (Archival Documents - Government Quantum Technology Roadmap; Government Industrial Strategy)

4.3 Phase 3: Ambivalence, Indecision & Emergence of QKD

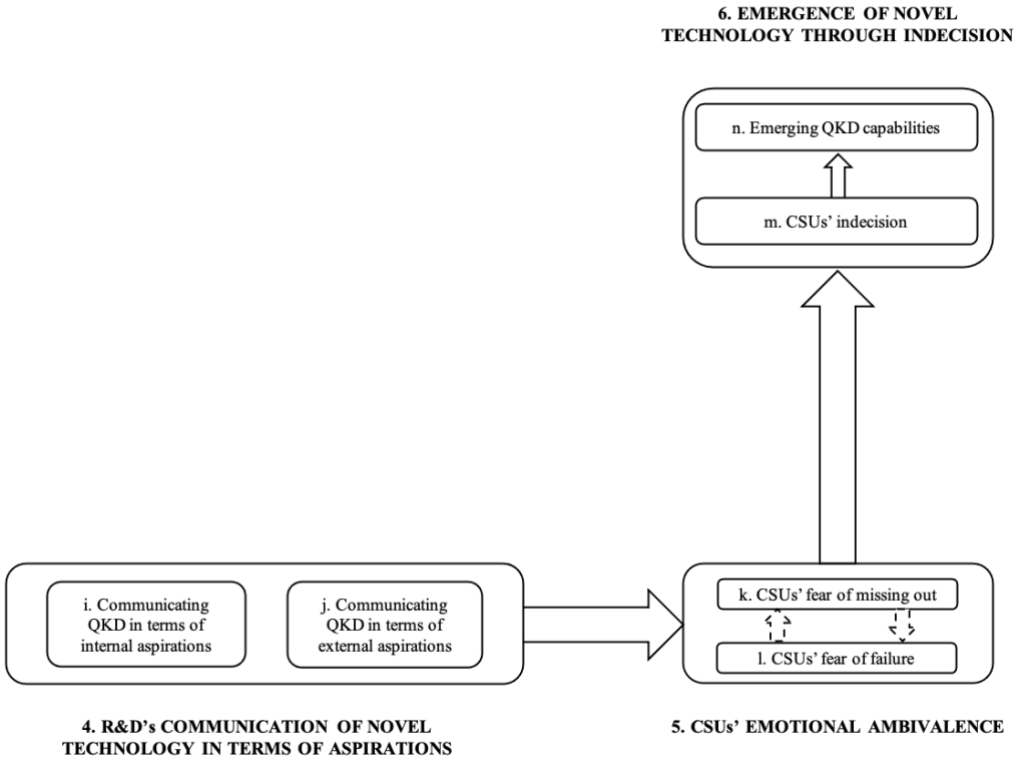


Figure 4.3 - Summary of Phase 3

CSUs' Emotional Ambivalence

Following the R&D department's framing QKD in terms of internal and external aspirations, there was a shift in position with respect to QKD on behalf of the CSUs, who started to experience emotional ambivalence (Ashforth et al., 2014). This ambivalence was manifest as dual fears of missing out and of failure, which contributed towards a feeling of being torn over whether or not to pursue or to reject QKD. The communicative efforts of R&D had made the potential market opportunity that QKD represented clear to the CSUs, whilst the movement of other market actors contributed towards a sense of missing out. Knowing that missing out would likely be embarrassing, this was construed as a

threat to the CSUs' wellbeing and thus created a fear of missing out on the opportunity, motivating the CSUs to engage with and pursue the technology as a means of avoiding this threat. At the same time, however, the thought of committing substantial resource towards the novel technology triggered a fear of failure within the CSUs. Failure to meet financial targets was associated with aversive consequences by managers within the TechCorp CSUs. When combined with their scepticism over the technology's likely commercial success, CSU managers perceived the pursuit of QKD may prevent them from achieving their goals. Thus, they also experienced a fear of failure when they considered QKD, which motivated avoidance tendencies that manifest as rejecting the technology in favour of something less novel and more certain.

(k) CSUs' fear of missing out

Although the CSU managers' early interpretations of QKD had been that it was a technology that was unnecessary for a number of years to come, the communicative efforts of the R&D department seemed to cause a shift in this position. While QKD remained commercially unproven, the speculative sales figures projected by R&D and the notion of 'providing trust' aligned with sovereign interests resonated with managers in the CSUs, who seemed to start to appreciate the potential commercial opportunity that the technology represented.

There was evidence globally of an emerging market for QKD, with reported quantum computing success stories reported by Google, IBM, Microsoft and Honeywell (Archival Documents - News & Media Reports). Functioning quantum computers fundamentally underscored the need for quantum secure communication capabilities, and despite there being contestation over Google's claims of quantum supremacy (Archival Documents - News & Media Reports), quantum computing was undeniably on the horizon. Members of the R&D department that I spoke with (OM 4, R&D; MM 5, R&D; OM 8, R&D), as well as members of the quantum community more broadly (TM 4, Govt; TM 1, Elevate Quantum), believed that state actors may in fact have functioning quantum computers already, but be keeping this news under wraps. In this respect, global business leaders held discussions about the possibility and consequence of the quantum computing threat, and concerns over the possible actions that this might enable "malevolent state actors" like China and Russia to take (Observations - Events 58 & 60).

Additionally, TechCorp were courted (separately) by long-term collaborators, OptiCo and Red Technologies (hereafter 'Red'), who wished to work together on fibre- and satellite-based commercial product launches respectively (Observations - Events 44 & 45). The combined cost that TechCorp faced for these investments was around $1 million in total (Observations - Event 45; Archival Documents – PowerPoint Slides from meeting between R&D and CSUs (Event 45)), with both entities accentuating the progress in domestic and international markets as a reason to move now. The motivation was clear, and despite TechCorp being their preferred partner, both OptiCo and Red were forthright that if TechCorp were not interested, they would look elsewhere. Red, in particular, were highly vociferous

and not shy in highlighting the progress they were making with the military in TechCorp's home market, as well as advances they had made with governments overseas.

In meetings between the CSUs and R&D, the possibility of missing out on these opportunities was addressed and branded as something that would be "highly embarrassing" (MM 3, CSU & MM 4, R&D in Observation - Event 46) and "terrible" (MM 5, R&D in Observation - Event 46) by managers present. Given Red's success overseas, there was a feeling that they had already "missed the boat" (MM 4, R&D) in at least one promising market, given the reputation of these countries as technologically oriented and forwards-thinking. One manager confided in me that this spurred "concerns that despite doing much of the pre-work, we [TechCorp] may fail to capitalize on the opportunity [that QKD represents]" (MM 5, R&D) and a desire to therefore act. CSU managers, in particular, reflected on similar historically missed opportunities, where TechCorp's failure to act with sufficient haste saw them miss out on technological opportunities to rivals despite doing a significant amount of proprietary work (Observations - Event 29, 31, 32, 33, 35, 37). An external informant that I spoke with recalled how TechCorp had "been stung before" (TM 1, Government) and seemed eager to avoid such a scenario occurring again with QKD.

In this vein, one CSU manager was described as being "*very* worried" (OM 4, R&D in Observation - Event 33) that they had "another Blockchain scenario on their hands" (OM 5, R&D in Observation - Event 33). TechCorp had previously been slow to act on Blockchain technology and other than some intellectual property, was seen by certain employees and parties internally to have failed to make a commercial success of the opportunity. During meetings, this CSU manager was adamant that TechCorp must act *now*, in order to avoid missing out – again (Observations - Event 35). Worries were also voiced over the possibility that OptiCo and Red may begin to work together, cutting TechCorp out of the equation (Observations – Event 51). Recently, the two organizations had become involved in a collaborative project together for the first time (Observations – Events 50 & 51; Archival Documents – News & Media Reports), leading to managers in both R&D and the CSUs speculating about the possibility of them beginning to work together to provide a holistic fibre and satellite commercial QKD solution, without TechCorp's involvement.

The anticipated embarrassment that missing out on QKD would cause was interpreted as a possible threat by CSU managers, leading to them experiencing fear responses with respect to missing out on QKD to their competitors. In other words, the CSU managers began to experience a fear of missing out. Repeatedly I was told that TechCorp had "missed out on stuff before" (OM 4, R&D), and that there was subsequently a "fear of looking like an idiot" (MM 4, R&D) amongst managers in the CSUs if that happened with QKD. Missing opportunities was damaging not only to the department, but also to the statuses of managers and groups within the CSUs, making them keen to avoid "squandering" (OM 8, R&D) this opportunity. Informal discussions I held with informants from the CSUs revealed that they were worried about stopping work on QKD, only for quantum computing to emerge and

TechCorp to be under-prepared. Such a scenario would inevitably lead to finger-pointing, and I was told that R&D TMs were prepared to point out that "the rest of the world are doing [QKD], and we're missing out because of you" (MM 4, R&D). In this respect, CSU managers "did not want to end up with egg on their face" (OM 2, CSU) over QKD. I was told by CSU informants that this fear was spurring the new interest and attention of the CSU TMs and subsequently MMs (Informal Discussions: January-March 2020), in order to avoid potential embarrassment. The desire to avoid potential embarrassment was particularly evident during a meeting between the CSUs and R&D department, where a CSU TM exclaimed about that the potential "embarrassment of our competitors doing something we couldn't do," going on to state that "we *need* to do it" in order to prevent this happening (TM 4, CSU in Observation - Event 70).

For the CSUs, taking no action with respect to QKD was perceived as a potential threat. Failing to act on the technology and missing out on the commercial opportunity to competitors was likely to entail embarrassment, something that the CSUs were all too familiar with. Accordingly, the CSUs were motivated to act in a way that could address or resolve this threat before it occurred. This seemed to be reflected in the heightened interest of the CSU managers and increased TM and MM attendance at meetings, both internally with R&D, as well as with OptiCo and Red (Observations - Events 30, 34, 35, 37, 42, 44, 45, 46, 48, 49, 51, 55). CSU TMs also began to proactively assign responsibilities amongst their subordinates for overseeing aspects of the QKD project (Observations - Events 62 & 63), ensuring they had a detailed understanding of the opportunity. Perhaps the most explicit example of the CSUs' change in perception and motivation to engage with QKD was at a meeting I attended between the CSUs and R&D department set up to discuss the commercial opportunity QKD represented. During this meeting, CSU managers tried to establish how to stump up the required financial resource to make the required investment, on the basis that "[they] couldn't miss out" (MM 2, CSU in Observation – Event 46). Again, CSU mangers referenced the potential embarrassment that losing out on this opportunity to near rivals would entail (Observations - Event 46). After this event, one R&D MM told me of their relief at the progress of the QKD project, and commented how this was the first time the CSUs had shown any "conviction" towards the technology (Informal Discussions). Subsequent informal discussions with various participants from both R&D and the CSUs converged on the idea that it was a fear of missing out on the opportunity that was driving the CSUs' interest in the technology. In this way, the CSUs' fear of missing out appeared to promote approach tendencies and a desire to pursue the technological opportunity, as a means of avoiding the threat of potential embarrassment.

(l) CSUs' fear of failure

While warming to the idea of QKD, and feeling a certain motivation to act in order to avoid the aversive consequences entailed in missing out, failure loomed large for managers in TechCorp's CSUs. Managers were highly concerned about failing to meet organizational revenue targets, with many informants telling me that the CSUs were cash-strapped (OM 2, CSU; OM 8, R&D, MM 4, R&D) and

that financial resource was very limited. In pursuit of "stretching revenue targets," the CSU managers "[couldn't] afford to fail because CAPEX [was] too tight" (OM 8, R&D), which translated into a general proclivity towards novel technologies and ideas that may or may not successfully contribute towards these targets. I was told that the CSU arm most likely to take on QKD had in fact been tasked with doubling their revenue in only a couple of years, leaving them largely unable to "make any strategic calls whatsoever" (MM 4, R&D) unless it was clear that the course of action could contribute towards this outcome. This insight was corroborated through informal conversations I had with various R&D and CSU personnel, as well as document analysis (Archival Documents - TechCorp Annual Reports).

Amongst CSU managers, failure was perceived to have severe consequences, both in terms of their status and job security. I was told that "socially, we [TechCorp] are not long out of the time when you *couldn't* fail" (MM 4, R&D), and an era where employees constantly "feared for their jobs" (TM 2, R&D), which subsequently impacted their propensity for risk-taking. Informal discussions again reiterated that CSU managers showed a preference for short-term and more incremental technologies that were less uncertain and more likely to deliver financially as a result (OM 3, CSU). CSU managers feared damage to their reputation if they performed poorly and failed to reach revenue goals and targets, which some believed could have career progression implications. This was evident during one interview with a CSU manager who, when asked about the CSUs' tendency to avoid dealing with novel technologies, alluded to threat that failure entailed by responding – with a look of concern on their face – "what if we get it wrong?" (OM 4, CSU).

There was evident scepticism about the successful commercial prospects of QKD amongst CSU managers. I was told in no uncertain terms that "there's still scepticism…about the commercial success of this technology" (OM 4, R&D) because "customers [were not] clamouring" (MM 5, R&D) for it. At one meeting between R&D and CSU figures, a CSU MM proclaimed "no one would be interested with those figures!" (MM 2, CSU in Observation - Event 71). Informants in the R&D department conceded that the uncertain financials "[don't] move the needle for them [the CSUs]" and that their apprehension with failure meant they would "only spend…on what's going to help hit their targets within the year" (OM 8, R&D). Internal economic models that I was shown – developed by R&D – indicated that the pay-back period for QKD stretched over a decade, making it incommensurate with the more near-term revenue goals of the CSUs (Archival Documents – R&D Techno-Economic Analysis; Informal Discussions). At a meeting I attended, members of R&D arrived at the conclusion that QKD might deliver anywhere in the region of $50 to $120 million in revenue, but could not arrive at anything more precise (Observation - Event 46). Even champions of the technology voiced doubts, with one R&D MM reflecting, "will QKD change TechCorp? I'm not sure…" (MM 5, R&D). As a consequence, one informant explained:

> "They're gonna say 'this idea of QKD might be worth $50 million over the next three years or so', somebody's going to say 'well I've got a limited amount of financial resource in

> developing new products and keeping the products going that I have right now, $50 million isn't going to move the needle. And you're telling me a quantum computer is 20 years away? I think I'll wait a while.' Generally, they're so busy—the accounts are busy trying to meet their targets, that it doesn't move the needle for them" (OM 8, R&D).

The CSUs' concerns about the aversive consequences of failure, combined with their scepticism pertaining to the technology's commercial prospects, meant that the thought of actively pursuing QKD was perceived as a threat to their revenue goals and triggered a fear of failure. CSU managers were "worried that QKD might undermine existing revenues on encryption today" (OM 4, R&D), preventing them from reaching their revenue targets. Equally, other CSU managers described how they saw QKD as a possible danger or threat because it didn't fit with their software-based strategy (MM 4, CSU), and was therefore perceived to be "too risky" (OM 1, CSU) an option to reach their revenue targets. When I pressed more deeply on this aversion towards QKD, I was told that the CSUs were "concerned about making money in the short-term" (OM 2, CSU) and meeting their goals because the company was "run by accountants" (OM 2, CSU) and therefore "next year's budget depends on this year's performance" (MM 4, R&D). QKD's inherent uncertainty meant that it was construed as a threat to achieving the CSUs' revenue targets, and failure had significant repercussions.

One TM that I spoke with was forthright in their assessment of this situation, stating that the CSUs "have a fear of taking on novel innovations and them failing" (TM 1, R&D). Other TMs that I spoke with concurred, describing the CSUs as "particularly fearful" (TM 5, R&D), while another reflected that the CSUs "went in [to meetings] looking for reasons not to [do QKD]" (TM 6, R&D). Similarly, MMs explained how they "had to de-risk *everything*" because the CSU managers were so "scared of the unknown" (OM 10, R&D). To circumvent this fear and get technologies downstreamed, R&D MMs told me they had to clearly build understanding around how novel technologies were aligned with the CSUs' revenue goals (Informal Discussions). In R&D meetings, MMs and OMs wondered whether the CSUs "could even be convinced" (Observations - Event 33), and debated whether or not it was worth involving the CSUs in meetings with emerging customers and triallists of the technology in case they further stoked their fear of failure unnecessarily. Following up with R&D participants after these events, I asked what they meant about convincing the CSUs and stoking their doubts respectively. Numerous informants referenced the CSUs' fear that QKD might prevent them from achieving their revenue goals. The CSUs' fear of failure was therefore deemed to impede the transition of novel technologies and ideas between the two departments.

Additionally, whilst not directly referencing the CSUs' fear of failure, a number of informants also described the CSUs as being "risk-averse" (MM 5, R&D; OM 11; R&D, TM 1, Government; MM 6, R&D; TM 1, R&D, OM 1, CSU). Extant research postulates risk-aversion as a potential behavioural consequence of experiencing fear (e.g. Lerner & Keltner, 2001; Lerner et al., 2003; Healey &

Hodgkinson, 2017), and whilst the two cannot definitively be linked, this further suggested that the CSUs held and/or experienced a fear of failure towards novel technologies like QKD.

When I asked CSU managers about these assertions (Informal Discussions), they agreed that the CSUs suffered from a fear of failure, and went on to say that this fear of failure was a principal factor in preventing their further engagement with QKD (and other novel technologies). While this short-sightedness was described as "petty" (OM 2, CSU), the consequences of failure were significant threats in the minds of CSU managers. Again, I was told that failure was considered to be consequential to career progression, whilst the implication of failing to reach a revenue target was that your resource might be slashed and re-allocated the following year. In this respect, a CSU MM described how fear of failure was "paralysing" for the CSUs, in that it made them unwilling to be accountable or assume responsibility for risk-laden decisions, such as the pursuit of highly novel technological opportunities (Informal Discussions, January – March 2020). Consequently, fear of failure motivated avoidance tendencies that contributed towards the CSUs' desire to reject QKD. Experienced alongside their fear of missing out, this created a situation in which there was no clear motivation to either totally accept or reject the technology. Instead, this contributed towards a state of ambivalence and subsequent indecision amongst the CSUs.

Table 4.5 - Illustrative Data for Aggregate Dimension 5: CSUs' Emotional Ambivalence

CSUS' EMOTIONAL AMBIVALENCE	
Second-Order Theme	**Illustrative Examples**
CSUs' fear of missing out (k)	"I think a lot of people – even though they can see a quantum computer is maybe a fair way off – they can see if it does become available, they think they're going to make geometric progression don't they, on quantum computers – so if you think it's 20 linear years, when actually it could be 2 or 3 years when one becomes available, that could massively change the game. And the risk that somebody comes along that someone comes along and says 'QKD isn't going anywhere, kill it' and then in three years' time, IBM or Google or somebody come up and say 'we've got meaningful quantum supremacy' what do we now? Who killed that project? Ah, you killed that project, why did you do that?….You shouldn't have done that!" (OM 8, R&D) "We can't have [competitor] beat us *again*." (TM 4, CSU) "Things are moving very quickly in this space, so there's a need to ensure we don't miss a trick. Otherwise, we might miss out [despite all the work proprietary work we've done]" (OM 4, CSU) Growing involvement of senior personnel from TechCorp CSUs in response to the commercial offering from Red Technology (Satellite QKD) (Observations - Events 45, 46 & 47)

	R&D MMs and OMs acknowledging change in behaviour and growing involvement of CSUs in conversation during their weekly team meetings, but branding their actions as a *"holding pattern"* because they were unsure whether to take on the opportunity or not (Observations - Events, 48 & 49) Claims of quantum supremacy by Google, suggesting that the threat of decryption from quantum computing was becoming more imminent and therefore the need for QKD was growing. Similarly, companies such as Microsoft announced their Azure service, and Amazon their Braket beta-service, both promising the benefits of quantum computing for consumers (Archival Documents – News & Media Reports) News of significant developments being made in the USA with a QKD service being offered commercially in major cities along the East Coast, while Delta Technologies announce they had received orders to build two new quantum cryptography networks in Europe and the United States. (Archival Documents – News & Media Reports)
CSUs' fear of failure (l)	"We communicate little risk [to the CSUs] when we talk with them. They're so risk-averse. The risk makes them scared of taking things – like QKD – on" (OM 10, R&D) "There is a perceived difficulty in failing [in the CSUs]. It has consequences" (MM 4, R&D) "I think for the CSUs…they are apprehensive because the revenue isn't near-term enough. It isn't clear how they will capitalize on it. It just seems too big a risk for them [to take on in light of their resource constraints and revenue targets]." (OM 8, R&D) "It's critical to bring [the CSUs] on the [innovation] journey so they aren't threatened and scared by the ideas we present to them" (OM 10, R&D) CSUs' unwillingness to commit evident at meeting between various parts of the business to discuss commercial propositions from OptiCo and Red Tech. Investment for both propositions were relatively minimal – approx. $1 million in total – and yet the CSU managers were very concerned about the ability of this to make a return, and whether there were budgets in place/that could accommodate the investments. (Observations - Event 46) Discussions with R&D MMs and OMs revealed that while some CSU managers voiced apprehensions about pursuing QKD, other members of the same division were pro-QKD. These individuals were solely focused on technology and were not accountable for revenue targets (showed no concerns about the economics of technology). They advocated TechCorp offering a commercial limited service, highlighting how the CSUs' fear of failure was fundamentally a fear of failing to hit revenue targets (Observations - Events 35, 57 & 60) News from the NIST competition for post-quantum algorithms, with some commentators beginning to talk about *"crypto-agility"* than encompasses both QKD and PQC, applying QKD only in places where heightened security was necessary. Indicative that market for QKD may not be as significant as portrayed (Archival Documents – News & Media Reports) Introduction of 'Innovation Cup' at TechCorp was a way of trying to encourage everyone in the business to be innovative and think about innovation, but also was

	aimed at trying to communicate that innovation was not something to be fearful of (Informal Discussions)

EMERGENCE OF NOVEL TECHNOLOGY THROUGH INDECISION

(m) CSUs' indecision

Having observed a shift in the CSUs' position towards QKD, the R&D department hoped that they might make a firm decision. However, this did not initially transpire, as I observed how the CSUs' ambivalence went unresolved for many months, preventing them from reaching a decision to either commit to, or reject, QKD.

Despite showing a marked increase in interest and engagement with QKD – as evidenced by their presence at, and contributions towards, internal meetings with R&D that I attended (Observations - Events 36, 37, 42, 46), and external meetings with prospective customers and collaborators – the CSU managers were unable to wholly commit to pursuing the technology. Although CSU OMs seemed to warm to the technology and offered to "act as back channels" (OM 2, CSU) for their R&D counterparts (Event 65), CSU TMs and MMs still made repeated references to QKD's uncertain market potential (Event 67). With R&D unable to offer any concrete figures on market size or revenue that might ameliorate these concerns, it was difficult for the CSU managers to commit the financial resources necessary for OptiCo and Red's venture propositions. Internal economic models that I was shown supported these apprehensions (Archival Documents – R&D Techno-Economic Analysis), as there remained a disjuncture between the technology's financial prospects and the performance aspirations of the CSUs. As one R&D OM told me, while QKD's revenue projections were "not insignificant", and they had been able to establish some "synchrony with the CSUs' strategies" throughout their various meetings, the level of uncertainty involved meant that QKD "still [didn't] move the needle" (OM 6, R&D) sufficiently to convince the CSUs to commit wholeheartedly.

Nevertheless, the CSUs demonstrated a general reluctance to totally reject and move on from the technology either. There were a growing number of success stories emerging globally from the United States and Japan (Observations - Event 66; Archival Documents – News & Media Reports), which suggested that R&D's prospections held some water and encouraged the CSUs to commit to the technology. In particular, Red continued to flourish, brokering a multitude of deals with major organizations, as well as national governments (Observations - Event 66; Archival Documents - News & Media Reports). Such news seemed to heighten the fear of missing out within the CSUs, who proactively organized meetings between various strands of the business to explore how they could might be able to pursue QKD commercially to avoid missing out on the opportunity. Reflecting their unwillingness to reject QKD, at one meeting I attended, CSU managers explicitly asked the R&D managers present to try and "keep [their counterparts at OptiCo and Red] sweet" (MM 3, CSU) whilst they established how they could make the venture propositions work, not wanting to let these

opportunities pass them by (Observations - Event 46). Numerous meetings were held over the following months, providing managers from the CSUs and R&D with platforms on which they could debate how TechCorp could invest in Red and OptiCo respectively, however they were still unable to arrive at a firm 'yes' or 'no' decision. It appeared that the fear of failure and fear of missing out, which constituted the CSUs' ambivalence, had created a state of indecisiveness that "[slowed] things down" (MM 7, R&D) and left QKD "bumbling along" (MM 5, R&D) for many months, without a firm decision on whether or not to pursue the technology

(n) Emerging QKD capabilities

Although no firm commit or reject decision was made for many months, work continued on the QKD project, and slowly but surely, QKD capabilities began to emerge at the organization. A capability refers to an organizational ability to reliably complete or achieve a specific purpose or outcome, and has been linked to possessing sufficient understanding and experience in that domain (Gavetti, 2005; Helfat & Winter, 2011; Eggers & Kaplan, 2013). The continued work on QKD involved planning and executing real-world trials of the technology, both internally on TechCorp's own networks, as well as externally with a manufacturing customer, based on the years of proprietary work that R&D had carried out (Observations – Events 48-72). These trials were described as successful by informants, which was "very positive" (MM 8, R&D) because they showed that QKD could take place across real-world networks. Informal discussions with R&D OMs involved in the external trial also revealed how planning and executing such trials provide them with a much better grasp of the technology and what was necessary to deliver it outside of a laboratory environment (Informal Discussions – May & June, 2020). Critically, it addressed critics who had cast doubt over QKD's real-world efficacy.

In providing experience, as well as furthering understanding, about QKD's commercial applicability, these trials were an important basis in the development and initial emergence of a QKD capability at TechCorp. Reflecting their emerging capability in this domain, R&D informants told me that they were contributing heavily to standards bodies to establish common criteria for QKD, and that these efforts were "really coming along" (OM 6, R&D; Observations – Events 70 & 71). Additionally, TechCorp's emerging expertise in the area of QKD was reflected by a surge in customer interest, with a number of organizations reaching out to TechCorp – as leaders in the field – to express a desire to trial and potentially use the technology (Observations – Event 68). Even CSU managers remarked during meetings between the departments that they were beginning "to see interest from customers" (TM 4, CSU). Arguably the most significant indicator that TechCorp had emerging QKD capabilities was the fact that government directly approached them over the prospect of working on a trial together (Observations – Events 62-64) in order to develop their own understanding of the technology.

Having prepared a report at the request of the CSUs on the consequences of a functioning, large-scale quantum computer manifesting (Observations – Events 53 & 56), informants reflected how in the last six months they felt like they had truly begun to understand what an encompassing quantum-secure

solution would look like (Observations – Event 67). They believed this was evident in their ability to articulate how QKD could be effectively combined with PQC in a coherent and commercially viable solution, and to deliver it in the real world as evidenced in recent trials internally and externally. In their minds, this proved that they had the requisite technical and business acumen necessary to deliver QKD and thus the capability to provide QKD was starting to emerge at the organization. It was also important because understanding the overall solution and business model through which they could effectively and profitably deliver QKD addressed long-standing concerns of the CSUs' regarding how QKD would make money. Being able to convey QKD and PQC as part of a hybrid system also made the technology more palatable to wider audiences, because PQC could be used to overcome QKD's distance limitations, which was often a voiced concern and reservation of potential consumers.

Although it was still early days in the grand scheme of things, the accumulation of understanding and experience meant that R&D personnel were increasingly confident about their emerging QKD capabilities. In fact, in one conversation an informant described how they envisaged that "nirvana would be a national QKD network" (OM 6, R&D). With their "improved understanding of the technology" they believed it was now a matter of ensuring they had the required number of personnel to install and manage the technology, along with "ensuring the robustness of the supply chain" (OM 4, R&D) in order to scale up operations for widespread deployment and consumption of QKD. In this manner, despite the CSUs' ambivalence towards the technology (Observations - Events 71 & 72), the period of indecision induced by this ambivalence appeared to inadvertently enable QKD capabilities to emerge at TechCorp. In providing time and space in which experience could be accumulated and understanding further developed and refined, TechCorp had begun to be able to reliably deliver the "specific and intended purpose" that was QKD (Helfat & Winter, 2011, p.1244). Whilst the managers at TechCorp were perhaps not consciously aware that they were doing so, they were on the path to successfully pursuing QKD as a novel technological opportunity.

Table 4.6 - Illustrative Data for Aggregate Dimension 6: Emergence of Novel Technology Through Indecision

EMERGENCE OF NOVEL TECHNOLOGY THROUGH INDECISION	
Second-Order Theme	**Illustrative Examples**
CSU indecision (m)	"QKD is important, and we appreciate we need to take a position on it" (TM 4, CSU) "Waiting for a decision on QKD from the CSUs is like watching continents drift" (MM 4, R&D) "Given the slot we've got, we should go ahead with the presentation and consider [name] concept as well, because it's more near term. However, we need to be careful about how the hour [slot] is spent. This is a global capability we're offering, and they [the CSUs] could get first dibs on it. But they need to make a decision." (MM 4, R&D)

	During meeting between TechCorp R&D and CSUs to discuss commercial propositions from OptiCo and Red Tech, CSU managers request R&D keep OptiCo and Red Tech relationship positive by finding other, similar avenues of work to continue collaborating on while they can arrive at a decision. This was due to an inability to arrive at a definitive decision with regards to either of their commercial propositions. during meeting. (Observations - Event 46) Informal conversations with those closely linked to QKD project indicate that the CSU managers are "*saying all the right things*" and while a decision on venture propositions was expected within a number of weeks, no decision was reached inside the next 6 months (Observations - Events 47-72; Informal Discussions) CSU TM & MMs increased availability for and participation in QKD-related meetings and discussions indicative that they think QKD is a good idea (e.g. request for quarterly meetings between CSU and R&D TMs). Further requests for R&D to produce 10-year roadmap for QKD, indicating desire to understand long-term implications in depth. Although acknowledging potential opportunity, CSU TMs remain unable to commit due to concerns over financials (Observations - Events 62-72)
Emerging QKD capabilities (n)	"We have an emerging understanding of the product, but it probably still needs to die its Three Deaths before we see massive progress." (MM 4, R&D) "We need them to acknowledge the fact that things are moving very quickly in this space and there's a need to double down on resources from a CSU perspective to make sure we're not missing a trick" (OM 6, R&D) "It's set up [QKD equipment at Customer C's site]! It's really working now!" (MM 5, R&D) "The technology is working really well [at Customer C's site]. The key rate is high. It's very stable. We have access via a VPN and haven't had to reset it since we were there a few weeks ago" (OM 10, R&D) TechCorp R&D provided a report on implications of RSA being cracked and how this would affect QKD and quantum computing. Suggestion that RSA would be evolutionary and therefore there would be a period where RSA/QKD/PQC were all used in conjunction with one another, before RSA was phased out and it was solely QKD/PQC. Indicated knowledge and understanding of how to deliver QKD in practice (Observations - Events 61 & 62) QKD equipment installed and trialled with manufacturing customer, in collaboration with OptiCo. Global press release/announcement signed off and delivered to report the successful implementation of the technology in this setting (Observations - Events 68-72; Archival Documents – News & Media Reports). Request for R&D to deliver an internal trial using QKD on TechCorp's own network satisfied and deemed successful by parties involved (Observations - Events 65 & 71) Invitation from branch of government for TechCorp R&D personnel to participate in meetings at the national level with regards to quantum computing and QKD, to tap into TechCorp's knowledge and wisdom as one of the major players this domain (Observations - Event 72)

	First of new quarterly meetings between R&D and CSUs regarding QKD held and described as going “really well” by R&D MMs. CSU TMs haven’t quite agreed to commercial propositions but success in providing trials deemed “big, positive news.” Emerging plans to do a further demonstration in [Location] in conjunction with University [Place] to evidence ability to show a QKD-secured metro network. (Observations – Event 72)

5 Discussion

In this thesis, I set out to understand how large, established organizations navigate the challenge of incumbency in order to successfully pursue and deliver novel technologies to the marketplace. Prior research has failed to explain how managers who recognize innovative opportunities gain the attention and support of key decision-makers, nor has it examined the role that emotions play in the pursuit of novel technological opportunities in incumbent organizations. Accordingly, I set out to answer two inter-related research questions: (1) *How do managers communicate novel technological opportunities in incumbent organizations, in order to gain the attention and support of key organizational decision-makers?* (2) *How does emotion affect the pursuit of novel technological opportunities in incumbent organizations?*

This research suggests that the pursuit of novel technological opportunities in incumbent organizations is inherently affective. While a number of emotions are experienced throughout this process, I found that fear was salient and experienced in different forms (fear of failure and fear of missing out). Interestingly, I found that fear seemed to propel this process forwards, in certain circumstances, rather than prohibit the pursuit of novel technology as prior literature would suggest. In fact, without the experience of fear, it seems likely that novel technology would have failed to emerge in the studied case. Relatedly, the presented findings highlight how middle and operational managers may articulate novel technologies in terms of negative emotions to capture the attention and support of key decision-makers. Attempts to articulate novel technologies in terms of positive emotions were rebuffed as emotional and irrational, whereas the same message but construed in terms of negative emotions was noticed and therefore seemed to be more effective. Finally, this research suggests that decision-makers may be ambivalent towards novel technologies, which can also cause them to be indecisive with respect to decisions regarding whether to accept or reject the technology. Indecision may – however – be beneficial in the context of pursuing novel technologies, despite prior literature suggesting otherwise. In light of these findings, this study provides contributions to the literature on innovation and emotion around three main themes:

(1) *To re-visit and provide a more balanced account of fear in the pursuit of novel technologies*, by showing how fear can behave as a productive mechanism that propels the pursuit of these technologies forwards. Specifically, when novel technologies are seen as a viable way to escape a feared threat, fear may motivate engagement with these technologies and lead to behaviours that facilitate their emergence. Such behaviours may include the communication of technological opportunities in terms of the aspirations they might help fulfil, as a means of building positive sentiment around, and underscoring how, these technologies are viable and worthwhile opportunities to pursue. This view is an alternative view to the prior literature on fear in the pursuit of novelty and innovation, which suggests fear impedes rather than propels such processes (e.g. Vuori & Huy, 2016; Brusoni et al., 2020). However, it is complementary, to the extent that emotions like fear trigger action tendencies opposed

to fixed actions (Ellsworth & Scherer, 2003), and thus fear – in certain circumstances – might lead to approach behaviours. Additionally, this study elucidates how different 'shades' and types of fear may exist in the incumbent pursuit of novel technology, namely fear of failure and fear of missing out. These distinct forms of fear can have their own unique motivational qualities that influence the innovation process in different ways, which has implications for how organizations and managers may choose to harness the power of fear. Accordingly, this study advances a more balanced and contingent perspective on fear.

(2) *To highlight the communicative strategies that middle and operational managers draw upon to convey novel technological opportunities*. Specifically, this study shows how more peripheral managers may communicate these opportunities in terms of – or to evoke – negative rather than positive emotions, as a means of capturing the attention and subsequent support of key organizational decision-makers. Through comparisons with prior literature on the topic (e.g. Raffaelli, Glynn & Tushman, 2019), this contribution informs a broader discussion of how novel technological opportunities may be communicated by top managers and middle or operational managers. Additionally, it draws attention to how aspirations can be used to help convey and establish the value of novel technological opportunities when communicating across departments or business units guided by different logics and corporate goals.

(3) By suggesting that the experience of emotional ambivalence (Rothman et al., 2017) by key decision-makers can lead to indecision, this thesis *furthers the positive perspective on ambivalence and explicates emotional factors that may contribute to indecision*. It explains how indecision might paradoxically be helpful to incumbent organizations pursuing novel technological opportunities by affording time and space for such technologies to develop and emerge, thus offering a more positive and contingent perspective on indecision as well. These findings also lead to a reconsideration of what it might mean to be 'inert' or suffering from 'inertia' in the context of incumbent organizations.

This discussion chapter is set out as follows: first, in *Section 5.1*, I synthesize my findings from the previous chapter and present a process model which explains the role that emotion can play in incumbent organizations as they pursue novel technologies, and how these emotions may in fact allow them to navigate the constraints of their incumbency. In *Section 5.2*, I elaborate on the three key contributions of this research, and discuss them in light of the existing literature. Specifically, in *Section 5.2.1*, I revisit fear in the pursuit of novel technological opportunities and attempted innovation, discussing how it might be a productive rather than destructive force (5.2.1.1). This brings into focus the potential importance of (negative) affect in the pursuit of novel technological opportunities (5.2.1.2), whilst I also discuss how different forms of fear might exist in this process (5.2.1.3). In *Section 5.2.2*, I consider how managers might communicate novel technological opportunities in incumbent organizations to enhance their likelihood of success, describing how managers can use aspirations to establish the value of these innovations (5.2.2.1) and delineating how top and middle or operational

managers may emotionally package such information (5.2.2.2). Finally, in *Section 5.2.3*, I extend the idea that emotional ambivalence can benefit the pursuit of novel technological opportunities in incumbent organizations, my point of departure being that the mechanism is the indecision that emotional ambivalence can create, something that the literature has not discussed previously (5.2.3.1). I also explain how indecision might benefit incumbents pursuing forms of novel technology, and attend to its emotional micro foundations (5.2.3.2). Having considered the theoretical implications of this study, I consider the practical, managerial implications in *Section 5.3*, before moving into the concluding chapter of this thesis.

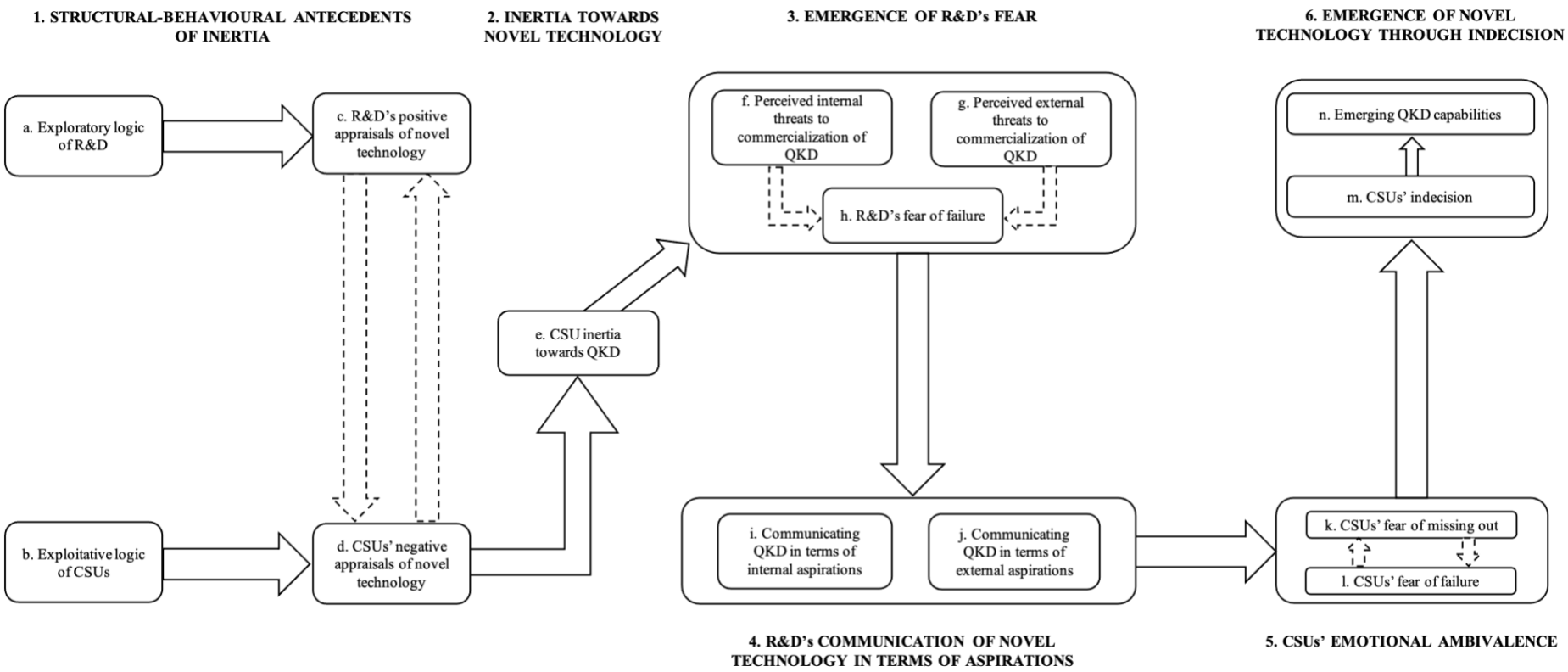


Figure 5.1 – A process model showing how emotion can affect the pursuit of novel technological opportunities in incumbent organizations

5.1 How emotion can affect the pursuit of novel technological opportunities in incumbent organizations: A process model

Incumbent organizations must balance the tension between remaining profitable in the short-run, whilst also being flexible and adaptable to environmental changes in the longer-run, which entails the effective combination of exploitative and exploratory activities (March, 1991; Tushman & O'Reilly, 1996). However, this can be challenging because exploration and exploitation are driven by fundamentally different logics and typically involve different goals. Thus, incumbent organizations may choose to house exploration and exploitation in structurally separate business units. This can prevent either exploitation or exploration interfering with the other, instead allowing each to focus on a discrete subset of corporate goals and activities without undue distraction.

Given the aforementioned difference in operating logic and corporate goals that exploratory and exploitative business units maintain (Figure 5.1 – see (a) and (b)), the assessment of novel technological opportunities can lead to the emergence of divergent appraisals. This is because each group are likely to consider novel technologies in terms of fundamentally different goals and criteria. Being well-aligned with the corporate goals of exploratory business units that are typically focused on delivering radically new products and services to the organization, novel technologies are likely to obtain *positive appraisals* (Figure 5.1 – (c)) from managers in this group. Conversely, because managers in exploitative business units are guided by economic goals and aspirations (e.g. revenue), the lack of demand for novel technologies can result in *negative appraisals of novel technology* (Figure 5.1 – (d)) being made, rooted in scepticism over the technology's immediate commercial prospects.

Such divergence can lead to contestation between exploratory and exploitative business units over the value and efficacy of novel technologies, and generally these contestations will resolve in favour of the more powerful actor (Pfeffer, 1981). Because exploitative business units are the source of financial resource to the organization, which is critical to its functioning and survival (Lavie, Stettner & Tushman, 2010), contestations will tend to resolve in their favour. As a result, incumbent organizations often demonstrate *inertia towards novel technologies* (Figure 5.1 – (e)) on the basis that novel technologies align poorly to the economic goals and aspirations held by exploitative business units and often receive unfavourable appraisals.

If exploratory business units have formed positive appraisal of novel technologies, they might expect that exploitative business units will pursue them. Thus, the rejection of novel technologies by exploitative business units can lead to a reassessment of their beliefs, to understand why this is the case. This search for information can lead to managers in exploratory business units recognizing factors that constitutes threats to the commercialization of novel technologies, both *internal* to the organization, as well as *external* (Figure 5.1 – (f) and (g)). Knowing that the successful commercialization of novel technologies hinges on support from exploitative business units, the aforementioned lack of support

(i.e. inertia towards novel technologies – Figure 5.1 (e)) may be a *perceived internal threat to the commercialization of novel technology*. This lack of support may be underscored by external factors such as a lack of customer support or demand, as well as a lack of belief and private investment in the technology from other industrial players. Such factors may be perceived as *external threats to the commercialization of novel technologies* on the basis that internal support in exploitative business units is often determined by the level of external support shown by customers, and confidence other organizations have in the technology's likely commercial success. Such factors can constitute threats to the goals of exploratory business units and prevent them from fulfilling their corporate goals and obligations for delivering novel technologies and services to the organization. In circumstances when these threats are perceived, failure is consequential, and exploratory business units have a limited or uncertain capacity to address this, exploratory business units may experience a *fear of failure* (Figure 5.1 – (h)).

While fear typically motivates withdrawal and avoidance (Frijda, 1988), when a novel technology is perceived as a viable option for avoiding or escaping a perceived threat or danger – such as the consequences of failing to fulfil organizational goals – fear may in fact motivate approach behaviours and engagement with such opportunities. In these circumstances, managers may proactively (re)frame technologies as viable and valuable opportunities to other stakeholders, as a means of trying to generate support for them (Healey & Hodgkinson, 2017). Creating positive sentiment around opportunities is important to try and ensure that these escape or avoidance options manifest, such that feared threats can be avoided. By *communicating novel technologies in terms of internal aspirations* (Figure 5.1 – (i)), exploratory business unit managers seek to align novel technological opportunities with corporate goals and targets that are valued by and meaningful to exploitative business units. The intention is to demonstrate commensurability and evoke positive emotions in such audiences to garner acceptance and support. Equally, exploratory business units may also try to *communicate novel technologies in terms of external aspirations* (Figure 5.1 – (j)). That is, they may try to show how novel technologies are aligned with goals and outcomes valued by actors external to the organization, but who the organization may hold in esteem or perhaps have an important relationship with, such as the government, a key customer or supplier. Doing so can help confer legitimacy onto novel technological opportunities by showing that others also see their value. Implicitly, it can also allude to the demand that exists for the technology, underscoring how the technology may help fulfil internal aspirations and goals around revenue generation. Fundamentally, communicating novel technologies in terms of the aspirations they may help fulfil can facilitate conversations with audiences who hold different guiding logics and corporate goals in a language they understand, in a way that can help to attract their attention and support in order to facilitate the pursuit of such opportunities.

Whilst communicating novel technologies in terms of the aspirations they can fulfil (i.e. as viable and valuable opportunities) may intend to highlight their commensurability with the goals of

exploitative business units in order to evoke positive sentiments and emotions, and engender their support to facilitate the pursuit of such opportunities, this may not necessarily happen. Despite potentially recognizing the significance of such opportunities, the inherent subjectivity of the appraisal process (Lazarus, 1991c) means that negative emotions might be elicited. In articulating the significance of the potential commercial opportunities, but ambiguity over who will capitalize on them, managers in exploitative business units might become aware that they may miss out on the opportunity to competitors. Such an eventuality – where competitors capitalize on an opportunity at the expense of exploitative business unit managers – can be a potential source of embarrassment. On the basis that missing out can cause embarrassment can constitute a threat to character and social standing, exploitative business units may experience a *fear of missing out* (Figure 5.1 – (k)). *Fear of missing out* may encourage managers to pursue technological opportunities on the basis that approaching and engaging with such opportunities might be a means of avoiding or averting this threat. However, at the same time, exploitative business units must often contend with finite resources and achieve stretching corporate goals around revenue generation, where a failure to meet organizational goals can entail certain aversive consequences. These may include a loss of credibility as an individual, group or organization, as well as having implications for resource allocation in following time periods. In circumstances where failure has consequences, and scepticism exists over the commercial prospects of novel technologies, the thought of pursuing novel technologies may also trigger a *fear of failure* in exploitative business units (Figure 5.1 – (l)). In order to escape from or avoid this *fear of failure*, managers in exploitative business unit may therefore be motivated to reject these technological opportunities (Figure 5.1 – (l)), which are perceived as threats or dangers to meeting organizational revenue goals.

The concurrent experience of *fear of missing out* and *fear of failure* can cause exploitative business units to feel torn and ambivalent towards novel technologies. Managers may be unsure whether or not to pursue these opportunities, and experience a simultaneous desire to pursue and reject them. In order to avoid their *fear of missing out*, managers in exploitative business units may be inclined to engage with and pursue novel technologies like QKD, as this can help avert the potential embarrassment of missing out on an opportunity to competitors. However, the uncertainty about the commercial success of novel technologies may create a *fear of failing* to meet corporate goals, which can motivate avoidance tendencies that manifest as withdrawal from or rejection of novel technological opportunities. When ambivalence stems from dual fears, and the escape and avoidance options for these fears are mutually exclusive (i.e. either option resolves one fear but might allow the other fear to manifest), ambivalence can be particularly enduring and difficult to resolve. Managers can find themselves trapped between not wanting to miss out on technological opportunities, but also having insufficient confidence in their commercial success to overcome their fear of failure and commit wholeheartedly. In these circumstances, ambivalence may cause managers to exhibit *indecision* (Figure

5.1 – (m)), due to their reduced ability to choose between the positive and negative aspects of this ambivalence. Subsequently, managers in exploitative business units may be unable to either accept or reject novel technologies for commercialization.

Whilst *indecision* may slow and/or prevent the progress of novel technologies through official organizational channels and processes, it can be beneficial, paradoxically. If exploratory business units can continue to work on these projects despite a lack of firm yes or no decision, engaging in further research and trials, for example, they can continue to accrue understanding and experience around novel technologies. These are critical components in the development and emergence of organizational capabilities (Helfat & Winter, 2011; Kaplan & Eggers, 2013) required to deliver such technologies, and thus can lead to *emerging capabilities* (Figure 5.2 – (n)) within the organization. In this way, incumbent organizations capacity to provide a novel technology may be developed and begin to emerge even though there has been no ostensible decision to pursue the opportunity. Fear may therefore be able to propel the emergence and pursuit of novel technological opportunities in incumbent organizations forwards when they are interpreted as a way to avoid a feared threat, leading to managers emphasising the opportunity and trying to build positive sentiment around them. Thus, fear may be able to help organizations navigate the challenges of incumbency.

5.2 Theoretical implications

5.2.1 Revisiting fear in the pursuit of novel technology and innovation

The major contribution of this thesis is to advance a more balanced account of fear in the pursuit of novel technological opportunities and attempted innovation, challenging the notion that fear is innately bad or problematic. In this manner, this thesis builds on Lebel's (2016; 2017) calls for a more contingent perspective towards fear and emotions more generally. The presented findings illustrate that although fear can – and will – trigger avoidance tendencies, in line with longstanding assertions in psychology (Scherer, 1984; Frijda, 1989; Lazarus, 1991a; 1991c; Russell, 2003; Damasio & Carvalho, 2013), as well as strategic management (e.g. Vuori & Huy, 2016; Zuzul, 2019; Brusoni et al., 2020), there are circumstances where fear might lead to engage with novel technological opportunities, and motivate opportunity pursuit (i.e. approach behaviour). Furthermore, whilst prior strategy and innovation scholarship has tended to portray fear as one universal concept (exceptions being recent work by Brusoni et al., 2020, as well as the entrepreneurship and psychological literatures on fear of failure – e.g. Conroy et al., 2001; Cacciotti & Hayton, 2015), the findings of this study highlight how fear may exist in different forms, detailing the existence and experience of both *fear of failure* and *fear of missing out*. Distinguishing how fear may emanate from specific stimuli is valuable because in keeping with the original intentions of the Carnegie School of scholarship – which sought to answer "how to manage and design organizational structures based on how actors in organizations behave" (Gavetti et al., 2012, p.28) – this this introduces the possibility of designing and managing organizations

and their processes in such a way that can capture the potentially helpful qualities of fear, whilst diminishing or reducing the negative consequences that might entail.

5.2.1.1 The productive potential of fear: When fear precedes approach tendencies

The presented findings highlight how the experience of fear can be salient in the pursuit of novel technological opportunities in incumbent organizations, and despite prior assertions, may in fact be able to motivate opportunity pursuit (i.e. trigger approach tendencies). As such, the principal contribution of this study is to challenge the prevailing view that fear is an impediment to attempts at organizational innovation and change (e.g. Liu & Maitlis, 2014; Vuori & Huy, 2016; Zuzul, 2019; Brusoni et al., 2020), and offer a more balanced account of fear as something that can be both advantageous and disadvantageous, depending on the circumstances.

Due to the inherent uncertainty associated with trying to innovate and pursue forms of novelty, scholarship has asserted that fear is likely to characterise such processes (Baumgartner, Pieters & Bagozzi, 2008; Brusoni et al., 2020), given that the experience of fear is in large part determined by uncertain dangers and threats (Lazarus, 1991c; Ellsworth & Scherer, 2003). Such a position is supported by the findings of this study, which show that fear can be experienced by various groups involved in the attempted pursuit of novel technologies. Yet, the findings of this study depart from prior scholarship, which suggests that the experience of fear will impede the pursuit of novelty and innovation by motivating avoidance and withdrawal tendencies (e.g. Vuori & Huy, 2016; Zuzul, 2019; Brusoni et al., 2020), or by causing dysfunctional patterns of behaviour (e.g. Hodgkinson & Wright, 2002). Although this study does show how such maladaptive outcomes are indeed possible, it also provides evidence that in circumstances where actors perceive novel technological opportunities as viable option to avoid or escape a threat that they fear, this fear may actually promote engagement with such technologies, and actions that may facilitate opportunity pursuit.

The presented findings suggest that fear motivated both the R&D department and CSUs to engage with QKD, when the pursuit of this novel technology was seen as a way in which managers could avoid or escape a feared threat. For R&D, delivering QKD was a way in which the department could meet organizational goals around innovation and prove their value (i.e. avoid the threat of failure), with managers referencing that "every two years, R&D needs a big win" (p.112) and R&D TMs declaring QKD as a "big bet" for the department, believing that it could provide this big win. Similarly, for the CSUs, QKD was seen as a way in which they could avert their fear of missing out on the opportunity to competitors. They discussed their "fear of looking like an idiot" as well as the "embarrassment of our competitors doing something we couldn't do," and that they "need[ed] to do [QKD]" to avoid this threat (p.126). Such approach behaviours are consistent with existing research on fear (Frijda, 1988; Lazarus, 1991c), which has postulated that fear will motivate action tendencies that protect actors from perceived harm, usually through withdrawal or avoidance. In this case, it was

deemed that by approaching and engaging with technological opportunities, it was possible to avoid feared threats.

Furthermore, the presented findings indicate that one way in which fear may promote opportunity pursuit is by motivating managers to build positive sentiment around such opportunities – or, as one manager put it, "building a burning platform" (p.115) around novel technology to gain the attention and support of exploitative business units. This occurred by managers communicating how QKD could help to fulfil valued organizational goals or aspirations (internal aspirations), as well as the goals or aspirations of other valued actors like government (external aspirations). By aligning novel technologies with valued outcomes, managers can underscore both the potential value and viability of technological opportunities, and when successful, this can breed positive feelings and sentiments towards them. Such insight aligns with conceptual work by Healey and Hodgkinson (2017), who suggested that managers will generally reframe novel strategic prospects in a way that can "foster a receptive emotional climate" (p.127). Typically, the cultivation of positive sentiment and emotion is preferable on the basis that positive emotions increase openness and acceptance of new information and options (Raffaelli et al., 2019). Whilst aspirations were used to establish positive sentiment in this study, in other contexts like a not-for-profit, alternative framings might be used, such as how technological opportunities might fulfil a social value or need.

The notion that fear may help to promote engagement with, and pursuit of, novel technological opportunities in contexts where such technologies are perceived as a viable escape or avoidance option aligns with research on the use of fear appeals (Witte & Allen, 2000; Ruiter, Abraham & Kok, 2001; Ruiter, Kessels, Peters & Kok, 2014). This line of work has shown that the use of fear appeals in marketing and healthcare are typically successful when a feared threat is conveyed but accompanied with a response or solution to the threat. It is the idea that it is possible to avoid such threats that lead to action. In this vein, there is evidence that when audiences "do not believe they are able to effectively avert a threat" (Witte & Allen, 2000, p.606), fear appeals are generally not effective in promoting action. Similarly, the idea that fear can promote action tendencies when actors deem there is a viable escaping option corresponds with recent assertions made by König et al. (2021). These scholars argued that the propensity for threat perceptions (which can be cognitive antecedents of fear – Smith & Ellsworth, 1985; Lazarus, 1991c; Smith & Lazarus, 1993) will facilitate attempts at radical innovation in incumbent organizations only when actors perceive a moderate level of control in addressing or dealing with the threat in question. Both this study and König et al. (2021) therefore adopt a similar line of reasoning, that whether threats and fear can motivate approach tendencies or not may depend on the belief the actors involved believe they can handle and overcome them. In contrast, when perceived control is low, there may be insufficient positive sentiment established to promote action, and thus resignation and helplessness may manifest (Lazarus, 1991a; 1991c) as actors do not see the value in trying. Alternatively, when perceived control is high, a threat may not trigger fear given that a central

appraisal in the experience of fear is a low or uncertain capacity to cope with situational demands (Lazarus, 1991c; Lerner & Keltner, 2000).

More broadly, the narrative that fear can have productive effects in the pursuit of novel technologies deviates from similar studies. For example, Vuori and Huy (2016) found that fear impeded Nokia's ability to innovate, whilst a lab experiment conducted by Brusoni et al. (2020) suggested that fear of change and fear of the unknown generally inhibited organizational exploration and innovative ability. The differences between this study and that of Vuori and Huy's (2016) are particularly interesting, given the similarities in the research contexts. Both studied organizations were large structurally differentiated incumbents pursuing particularly novel technological opportunities in communications markets. However, a comparison of the findings underscores how fear's productive potential (i.e. ability to motivate engagement with technological opportunities and facilitate their pursuit) may lie in the experience of fear being accompanied by perceptions of a viable escaping option. At Nokia, middle managers did not see a way in which they could viably escape from the threat posed by top managers, leading to them submitting to unrealistic requests and targets from these top managers. This can be understood as a short-term prioritization of personal goals by averting an immediate threat, even though in the long-run middle managers were aware this was likely to be detrimental to the organization. Subsequently, Nokia's top managers implemented a strategy that they thought was viable but was in fact inappropriate. Fear created a dysfunctional communicative dynamic that ultimately contributed to a failure of the innovation process at Nokia (Vuori & Huy, 2016; 2021; Healey & Hodgkinson, 2017), whereas at TechCorp fear was productive in the sense that it helped to drive the pursuit of novel technology forwards. When fear motivated approach tendencies amongst R&D and CSU managers at TechCorp respectively, it was accompanied by a belief that the pursuit of QKD could feasibly allow them avoid their feared threats (failure to deliver value and innovation leading to department closure for R&D; missing out on QKD leading to potential embarrassment for the CSUs). Thus, fear behaved as a catalyst. This distinction in whether or not fear will trigger avoidance or approach resonates with Hodgkinson and Wright's (2002) work, in which they suggested fear in the absence of a viable escaping option can lead to a number of dysfunctional behaviours and outcomes manifesting. Relatedly, Healey and Hodgkinson (2017) – albeit conceptually – posed that negative emotions may be crucial elements of the pursuit of organizational innovation, and often entail reframing on behalf of managers where technologies or options are construed in positive terms. In other words, that they are viable options for escaping or avoiding threats, in order to develop positive sentiment towards them.

Similarly, Brusoni et al. (2020) argued that fear of change (i.e. attachment to the status quo) and fear of the unknown can prohibit organizations from exploring truly distant domains. Therefore, fear is portrayed as problematic because it impedes the exploration of distant domains where highly rewarding options often reside (Gavetti & Levinthal, 2000; Gavetti, 2012). Parallels exist between the concept of

fear of failure presented in this study, and what Brusoni et al. (2020) call fear of change. In both studies, fear seems to stem from the level of confidence that actors hold in the future success of an unknown, or lesser known, alternative. It is said that "the greater the distance, the stronger the fear of failure" (Brusoni et al., 2020, p.212) because actors are less able to tell whether the option will be successful or not. One could argue that the difference between R&D's and the CSUs' fear of failure at TechCorp was perhaps the degree of confidence they had in QKD's commercial success, and – by extension – how viable they saw it as an escape option. The R&D managers – who saw QKD as a viable way to address threats regarding the survival of their department – seemed confident of success. Conversely, the CSUs' scepticism was apparent, indicating less confidence in QKD as a solution to the threat of not meeting their revenue targets. Whereas fear of failure preceded approach tendencies in R&D, it preceded avoidance tendencies in the CSUs. This reiterates how the ability of fear to act as a potential motivator of the pursuit of novelty, and more broadly in organizational innovation, may depend on the degree of confidence (i.e. certainty) actors have in novel opportunities being viable ways to avoid threats and dangers. In this respect, this study takes Brusoni et al. (2020) work further by identifying certain conditions under which fear might be more productive and promote approach rather than avoidance tendencies. Namely, for fear to trigger approach tendencies, it may require at least a moderate degree of control and confidence that the fear can be managed or avoided. Such a position is more in line with psychological perspectives on emotions and fear, which have long argued that emotions trigger action *tendencies* opposed to fixed actions (Ellsworth & Scherer, 2003). Indeed, it is consistent with the idea that nuances in the appraisal process linked to perceptions of control or coping ability (Lazarus, 1991a; König, Graf-Vlachy & Schöberl, 2021) may trigger different behavioural responses.

Considering the findings of this study in light of extant research concerning fear in the innovation process (Vuori & Huy, 2016; Brusoni et al., 2020), one implication is that our existing understanding of fear is perhaps underspecified. Labelling fear as something inherently 'bad' for (attempted) innovation is insufficient because there are circumstances in which it may be a powerful motivator of action. In this manner, a more contingent perspective on fear (as proposed by Richard Lebel [2016; 2017]) is necessary because the "behavioural responses to…fear are situationally contingent," (Lebel, 2017, p.2017). A contingent perspective corresponds more closely with research on fear in adjacent fields like entrepreneurship and psychology, where – for example – it has been acknowledged that fear may act as an inhibitor of entrepreneurship, as well as being a strong motivator *for* entrepreneurial action (Mitchell & Shepherd, 2011; Cacciotti & Hayton, 2015; Cacciotti et al., 2016; Shepherd & Patzelt, 2018). Equally, as previously discussed, psychology has long maintained a contingent perspective on fear and emotions, the subjective nature of the appraisal process meaning an array of different actions are possible (Smith & Lazarus, 1993; Elfenbein, 2007). Rather than promoting fixed actions, emotions trigger action tendencies designed to improve a person's relationship with the environment (i.e. to make it more favourable [Ellsworth & Scherer, 2003]) by whatever means are

deemed appropriate. Although fear is generally associated with withdrawal or avoidance tendencies – as a means of avoiding or reducing exposure to a threatening or harmful stimulus, in order to boost an individual's chances of survival (Russell, 2003; Frijda, 2007; Izard, 2009) – this does not preclude fear from motivating approach tendencies if that is deemed the more appropriate way in which to escape a feared threat (Damasio & Carvalho, 2013; Fisher, 2019). Vitally, it is whether novel technologies are the source of such fears – as with the CSUs' fear of failure – or perhaps a way of escaping or avoiding fears, as was the case with R&D's fear of failure and the CSUs' fear of missing out.

5.2.1.2 The utility of (negative) affect in the pursuit of technological opportunities

In situating fear as something that could facilitate the pursuit of novel technological opportunities in incumbents, this study reaffirms the importance of affect as a possible mechanism through which incumbents may be able to overcome the inertial tendencies and forms of myopia said to afflict them (cf. Nelson & Winter, 1982; Henderson & Clark, 1990; Levinthal & March, 1993; Tripsas & Gavetti, 2000; Eggers & Kaplan, 2009). The literature is populated with numerous structural and cognitive mechanisms for overcoming inertia; for example, establishing slack resource can permit exploration of new domains (Cyert & March, 1963; Meyer, 1982). Similarly, a corporate culture that is willing to cannibalize extant resource bases (Reinganum, 1983; Gilbert, 2005; Benner, 2007) can be a way in which incumbents may be able to explore new and emerging technologies and solutions, as a precursor to adaptation. However, these cognitive and structural perspectives assume managers process information in an affect-free manner, as assertion that has been strongly refuted by research in psychology (Hodgkinson & Healey, 2011). Information is processed for both 'rational' reasons (i.e. to identify the best alternative and make a decision) but at the same time is interpreted in terms of its implications for meaningful goals and wellbeing (Ellsworth & Scherer, 2003; Scherer & Moors, 2019). Accordingly, the existence of slack resources or a corporate willingness to cannibalize may still be insufficient to trigger the pursuit of novel technological opportunities if managers appraise the situation in such a way that triggers avoidance or withdrawal behaviours, or simply lack the motivation to act.

In this respect, Hodgkinson and Healey (2008; 2011; 2014; also Healey & Hodgkinson, 2017) have argued that affective factors are crucial in organizational innovation, and emphasised the need to consider both cognition *and* emotion. For example, individuals may shield themselves from disconfirming information in the so-called 'Ostrich Effect' (Karlsson, Loewenstein & Seppi, 2009), preventing them from engaging in cognitive change. Subsequently, this can prohibit innovation from taking place (Hodgkinson & Healey, 2011). Equally, the "fostering [of] appropriate emotional reactions" is a critical enabler of innovation and change (Hodgkinson & Healey, 2011, p.1502), particularly positive emotions (Healey & Hodgkinson, 2017). This study therefore builds upon their work, with the presented findings corroborating that emotion can be a critical mechanism in innovation, and by illustrating how negative emotions might be able to drive the pursuit of novel technological opportunities. While Healey and Hodgkinson have stressed that negative emotion often encumbers

attempts at innovation and change, they did also acknowledge how negative affect may "exert some surprisingly functional effects" (Hodgkinson & Healey, 2011; Healey & Hodgkinson, 2017, p.117), an idea supported – and evidenced – by this study.

By showing how fear can have these "surprisingly functional effects" (Healey & Hodgkinson, 2017, p.117) in the incumbent pursuit of novelty, this study provides a more balanced account of fear as something that is not inherently bad or problematic. Rather, it might be a useful mechanism for efforts at innovating and change (cf. Staw, Sandelands & Dutton, 1981; Tushman & O'Reilly, 2002; Vuori & Huy, 2016; Raffaelli, Glynn & Tushman, 2019; Brusoni et al., 2020). The presented findings therefore stress how the pursuit of novel technological opportunities in incumbents can be innately affective, while also accentuating how the presence of emotion in the decision-making process will not necessarily lead to 'irrational' and sub-optimal outcomes as some may assume. Rather, emotion – specifically, fear – might actually help to overcome the various "dysfunctions of decision making" (Hodgkinson & Healey, 2011, p.1502) that lead to novel technological opportunities being routinely rejected in incumbent organizations (e.g. Tripsas & Gavetti, 2000; Benner, 2009; Danneels, 2011). Accordingly, this study addresses a relative paucity of research into the role that emotion plays in the pursuit of novelty, whilst also responding to calls for research that combine the cognitive and emotional in decision-making (Simon, 1967; 1987; Gavetti, 2005; 2012; Cohen, 2007; Hodgkinson & Healey, 2011; 2014; Healey & Hodgkinson, 2017). Doing so, the presented findings also help to explain instances that diverge from paths predicted by purely cognitive scholarship (e.g. Cyert & March, 1963; Walsh, 1995).

5.2.1.3 Different types of fear in the pursuit of novel technologies: Fear of failure and Fear of missing out

A cursory read of the literature on fear in the innovation process, and organizational life more generally, would suggest that fear is a solitary concept and universal experience. Prior management scholarship has rarely attempted to differentiate or delineate between different strands or types of fear (e.g. Kish-Gephart et al., 2009; Lebel, 2016; Vuori & Huy, 2016), although entrepreneurship and psychology scholars alike have examined fear of failure (Conroy, 2001a; Conroy & Elliot., 2004; Mitchell & Shepherd, 2011; Cacciotti & Hayton, 2015; Cacciotti et al., 2016; 2020) and fear of missing out (Collins, 2013; Pryzbylski et al., 2013; Hodkinson, 2019; Dogan, 2019; Snellman & Cacciotti, 2019) respectively. However, the findings of this study show how managers in incumbent organizations pursuing novel technological opportunities may experience different types of fear. Namely, *fear of failure* and *fear of missing out*. This is valuable because – in keeping with the original intentions of the Carnegie School – such understanding may permit organizations to be designed and managed in such a way as to harness the benefits that fear offers, whilst mitigating its potential drawbacks.

Identifying fear of failure as an emotion that groups of managers experienced intermittently throughout the attempted commercialization of QKD is somewhat unsurprising. R&D departments like the one studied can be understood as locales for entrepreneurship within the confines of established firms (Burgelman, 1983), and fear of failure has been commonly reported in studies on entrepreneurship (for a review, see Cacciotti & Hayton, 2015). It is therefore reasonable to expect similar emotional experiences occurring across comparable contexts. Equally, exploratory and exploitative business units like those studied are subject to taxing targets, where failure can entail aversive consequences that actors wish to avoid. The idea that fear of failure can trigger both approach and avoidance behaviours aligns with prior work in both psychology (e.g. Conroy, 2001a) as well as entrepreneurship (e.g. Cacciotti et al., 2016; 2020), where research has shown fear of failure to both motivate and inhibit effective performance amongst elite sports performers and entrepreneurs (also see Conroy & Elliot., 2004; Conroy & Coatsworth, 2004; Mitchell & Shepherd, 2011; Cacciotti & Hayton, 2015; Shepherd & Patzelt, 2018). The contingent perspective adopted by these scholars departs from earlier theorizing which positioned fear of failure as an impediment to entrepreneurship and sports performance, and failed to consider how it could benefit actors in these scenarios. The findings of this study further corroborate this contingent perspective on fear of failure and offer significantly more nuance to our understanding by providing empirical evidence regarding the dynamics of fear of failure in corporate environments. This is important because while fear of failure has been referenced in previous studies, scholars have rarely dwelled upon nor unpacked the concept in much depth[31] (e.g. Mantere, 2008; Hodgkinson & Healey, 2014; Healey & Hodgkinson, 2017; Heyden et al., 2017; Smets, Morris & Greenwood, 2018; Kammerlander, König & Richard, 2018). In contrast, this study provides empirical evidence of how and when fear of failure may promote or impede the pursuit of novel technological opportunities (as discussed in detail in 5.2.1.1).

Perhaps more importantly, in identifying that fear may trigger approach tendencies in certain circumstances, the presented findings suggest that the trend to normalize failure is short-sighted and perhaps misplaced (Shepherd, Covin & Kuratko, 2009; Shepherd, Patzelt & Wolfe, 2011; Shepherd & Patzelt, 2018; Danneels & Vestal, 2020). Making failure a part of everyday life could reduce opportunities to experience fear of failure, and prevent its potentially motivating and productive qualities from being utilized for the benefit of the organization. Taking the findings of this study into account, it may be possible to cultivate a fear of failure by emphasising the dangers of not meeting organizational goals, and position novel technological opportunities as a way to avoid them, or prevent them from manifesting. This may spur action and help incumbents to navigate the inertial factors they face, aligning with comments about how emotions may be used in a more utilitarian fashion in

[31] Scholars have sometimes referred to fear of failure explicitly, whereas in other circumstances they have addressed it more implicitly by speaking about the fear of aversive consequences associated with failing or not achieving a specific goal or outcome.

organizational strategy and (attempted) innovation (Healey & Hodgkinson, 2017). In this way, the findings of this study can help with the design and management of organizations and their processes such that they run effectively, which was a core aim of behavioural research (Gavetti, 2012; Gavetti et al., 2012).

Additionally, the presented findings illustrate how managers in incumbents can experience fear of missing out as they try to pursue novel technological opportunities. This experience stemmed from appraisals that if they did not pursue a novel technology while their competitors did – and the technology ended up being successful – then the managers would be embarrassed. This anticipated embarrassment was construed as a potential threat or danger to their social esteem and status, subsequently triggering fear responses in the present and motivating managers to try and avoid this outcome[32]. Such a process aligns with prior work that has emphasised how prospective or anticipatory emotions (in this case, embarrassment), can lead to immediate and presently experienced emotions (i.e. fear of missing out) (see Loewenstein & Lerner, 2003; Baumgartner, Pieters & Bagozzi, 2008; Wilson & Gilbert, 2011; Dane & George, 2014). In this manner, while fear of missing out still motivates avoidance tendencies in order "to separate oneself from aversive events" (Frijda, 1986, p.72), in this situation, avoiding the threat involves approaching or engaging with a given course of action. This echoes prior research on fear of missing out (e.g. Pryzbylski et al., 2013; Snellman & Cacciotti, 2019), but is particularly interesting because in the context of incumbents trying to innovate, if fear of missing out promotes taking action, it could be useful in helping incumbents overcome the inertial forces that plight them (see Gilbert, 2005; Eggers & Kaplan, 2009). Additionally, this thesis differs from studies that have previously explored fear of missing out because it conceptualizes and treats fear of missing out as an actual emotion, stemming from appraisals of potential embarrassment. Previously, fear of missing out has not been treated as a true emotion. Instead, work in psychology has discussed the concept as a sense of missing out, using theoretical the likes of self-construal theory (Dogan, 2019) or self-determination theory (Pryzbylski et al., 2013), rather than conceptualizing it as an actual fear, as in this study.

A critical aspect of fear of missing out was that it seemed to derive from social evaluations (i.e. 'others might do something whilst we cannot, or do not'). In the studied case, the basis of the CSU managers' fear of missing out was the comparisons they drew with competitors who were pursuing the technology, which had emotional consequences for the managers at TechCorp. Not only does this underscore the importance of making appropriate social comparisons, but it introduces the possibility that fear of missing out could motivate dysfunctional behaviour if the point of reference used in

[32] Although fear of missing out seemed to promote approach tendencies, this was a manifestation of avoidance behaviour. In order to avoid the threat of potential embarrassment, managers were drawn to accept and pursue QKD as a means of escaping or avoiding the threat. As with R&D's fear of failure, it was the positive sentiment to avoid a threat that ultimately drove approach behaviours (i.e. the mechanism was ultimately the same).

comparisons are inappropriate. Research has explored social comparisons under rubrics like aspirations (Cyert & March, 1963; Shinkle, 2012) and reference points (Ansoff, 1979; Fiegenbaum, Hart & Schendel, 1996), and shown them to be an almost everyday occurrence in organizations, meaning that there are plentiful opportunities to experience fear of missing out. More importantly, it has been shown that managers often hold and use striving social aspirations to aid organizational decision-making (Labianca, Fairbank, Andrevski & Parzen, 2009; Hu, He, Blettner & Bettis, 2017). Striving aspirations involve managers and organizations comparing their performance and actions to similar but higher performing firms that they strive to be like. It is feasible that striving social aspirations could trigger a fear of missing out, promoting actions that are inappropriate because an organization is comparing themselves to an unequivocal entity. To illustrate: a small online bookstore might compare themselves to Amazon, and could experience fear of missing out on the basis of an action that Amazon – a similar but ultimately incomparable entity – take. Ameliorating their fear of missing out would involve following suit, but this might be wholly inappropriate and dysfunctional for the small online bookstore. In this respect, a contribution of this study is to indicate what emotional consequences or dynamics may arise from the use of striving social aspirations, reiterating the need for managers and organizations to be careful when they choose and use reference points in their decision-making. This mirrors assertions regarding the use of analogies in decision-making (e.g. Gavetti, Levinthal & Rivkin, 2005; Cornelissen & Clarke, 2010) where it is crucial to ensure that the source of the analogy has deep structural similarities to the target situation. Failure to do so (i.e. using a superficial analogy) can lead to inappropriate decisions being made.

The notion that fear of missing out can trigger dysfunctional behaviours in incumbents also brings into focus and reiterates the importance of effective emotion regulation in organizations (Gross, 2014; Vuori & Huy, In-Press). For example, if fear of missing out is triggered by an inappropriate social comparison, the ability to effectively down-regulate this emotional experience through reappraisal, for example, could mitigate the possibility of negative consequences ensuing. Equally, if fear of missing out does have strong motivational capacities, it might be useful for managers to be able to evoke fear of missing out in organizational actors as a means to try and overcome inertial forces. In this manner, the findings of this study also bare relevance to the literature on the microfoundations of dynamic capabilities (Hodgkinson & Healey, 2011; Helfat & Peteraf, 2015; Helfat & Martin, 2015; Huy & Zott, 2019) by highlighting how emotion regulation is an important managerial capability to enable organizations to remain dynamic and adaptive. In fact, the arguments presented in this thesis regarding incumbents harnessing and using emotions like fear to pursue novel technologies (i.e. facilitate dynamism and adaptation) are ultimately predicated upon the ability of managers to recognize and understand the emotional dynamics of situations they face or are involved in, in terms of what is necessary to achieve a specific outcome.

5.2.2 *Communicative strategies of managers in the pursuit of innovation*

The second major contribution of this study relates to how middle and operational managers might communicate novel technological opportunities in a way that facilitates their adoption and pursuit. Specifically, the presented findings showed how managers draw upon internal, organization-specific aspirations[33] as well as external aspirations held by other relevant and notable actors, in order to articulate the value that novel technological opportunities represent. These findings also highlight how the communicative efforts of these managers were only effective when they evoked negative emotions in key decision-makers. In this respect, this study advances our understanding of how novel technological opportunities might be communicated to influence key organizational decision-makers and garner their attention and support, responding to calls for research which examines how communication is used in a political manner (Cornelissen, Durand, Fiss et al., 2015; Ocasio, Loewenstein & Nigam, 2015; Ocasio, Laaamanen & Vaara, 2018). The presented findings also embolden our understanding of managers as skilled rhetoricians who shape and direct the attention and interpretation of other organizational members (e.g. Gioia & Chittipeddi, 1991; Dutton & Ashford, 1993; Fiss & Zajac, 2006; Maitlis & Lawrence, 2007; Kaplan, 2008; Kellogg, 2009), not only by influencing how organizational actors think, but also how they feel, thus contributing to the emerging literature on emotional framing (Voronov & Weber, 2016; Giorgi, 2017; Raffaelli, Glynn & Tushman, 2019).

5.2.2.1 *Communicating novel technological opportunities using aspirations*

In drawing attention to how novel technologies can fulfil internal, organization-specific aspirations, as well as the aspirations of other relevant and important organizations, managers are able to convey the significance of novel technological opportunities and thus paint them as significant organizational issues. This is important because it can help to capture the attention of top managers, who tend to allocate their attention only to high stakes or high pay-off issues due to their finite attentional resources (Dutton & Ashford, 1993; Ocasio, 1997). Showing how novel technologies are aligned with prescribed organizational goals therefore constitutes one way in which middle and operational managers can portray these innovations as high stakes and pay-off issue. Given the commercialization of novel technologies involves interaction between exploratory and exploitative business units (March, 1991), the use of aspirations is also a way in which it is possible for managers to tailor their language (Elsbach & Kramer, 2003) to that of decision-makers who reside in alternative departments, and are governed by different logics and goals. Doing so is an important aspect of making technological opportunities more understandable and palatable. In the presented findings, the internal aspirations used were the CSUs' revenue generation targets, and thus the use of economic figures and

[33] Please note that I use the terms goals, reference points and aspirations interchangeably, following other innovation scholars (e.g. Greve, 2003a; Gavetti et al., 2012; Posen et al., 2018).

language helped to capture the attention and build understanding amongst CSU decision makers. Establishing alignment between novel technologies and prevailing organizational goals and values is critical, given prior research has shown how a lack of alignment can prevent the pursuit of novel technologies (e.g. Kaplan, 2008; Kellogg, 2009; Giorgi, 2017). For example, Polaroid's inability to deliver digital photography to the marketplace – despite having developed the technology and having the capacity to do so – has been attributed to the lack of alignment between the innovation and the razor-and-blade model which was the salient frame held by top managers at the organization (Tripsas & Gavetti, 2000; Giorgi, 2017).

The presented findings also show how managers may communicate how novel technologies are aligned with the aspirations of other relevant and important organizations ('external aspirations'). Such a move may be intended to further legitimate novel technologies in the eyes of decision-makers by showing how the belief in the technology's efficacy and value is not idiosyncratic, but shared by other relevant and legitimate actors. In some cases, such as the findings of this study, by highlighting how other organizations – in this instance, the government – hold aspirations to consume, use or engage a novel technology, middle and operationial managers can reiterate how novel technologies are aligned with internal aspirations, around revenue generation, further establishing their value and creating further alignment. It is permissible that the aspirations of other important organizations or actors, such as critical customers or customer segments, regulatory bodies or suppliers may, may be used in this way.

In this manner, the findings of this study reinforce the importance of the communicative capabilities of managers, as has been asserted in prior research (Helfat & Peteraf, 2015; Helfat & Martin, 2015), showing how middle and operational managers can draw upon organizational aspirations in a rhetorical manner in order to frame and package novel technological opportunities persuasively, and in a way that may resonate with the language and goals of key decision-makers. Thus, this study helps to advance our understanding of how managers can use communication politically in order to affect the attentional dynamics of the organization and to exert influence on decision-makers (Ocasio, Laamanen & Vaara, 2018). Additionally, this study also highlights the role that aspirations can play in organizations past the context of performance feedback (Shinkle, 2012; Gavetti et al., 2012; Posen et al., 2018).

5.2.2.2 Emotional packaging of novel technological opportunities

The presented findings show how the way in which middle and operational managers communicate novel technological opportunities in emotional terms can affect whether they gain the support of key decision-makers. Specifically, the presented findings illustrated that these managers were only successful in gaining the attention *and* support of decision-makers when they evoked fear, a

negative emotion[34]. Their efforts to convey same information but packaged in terms of awe, a positive emotion (Keltner & Haidt, 2003; Chirico, 2020), gained little attention and were swiftly dismissed, which is interesting because it contravenes extant research pertaining to how novel technological opportunities should be communicated. Prior scholarship attending to this phenomenon has argued that innovations should be communicated using, or seeking to evoke, positive emotions (Van den Steen, 2005; Ravasi & Schultz, 2006; Rindova, Dalpiaz & Ravasi, 2011; Raffaelli, Glynn & Tushman, 2019). In contravening these insights, the findings of this study therefore suggest that current theorizing around how to communicate novel technologies is underspecified.

Previously, scholars have suggested that novel ideas and opportunities should be framed in a way that helps generate positive emotions. For example, communicating novelty in terms of positive, opportunity narratives was found to lead to facilitate change at Bang and Olufsen and Alessi (Ravasi & Schultz, 2006; Rindova, Dalpiaz & Ravasi, 2011). Similarly, Raffaelli, Glynn and Tushman (2019) suggested that by communicating the adoption of platform technology – a non-incremental innovation – in terms of positive emotions, Netflix were able to successfully pursue their now signature online platform, which enabled them to outcompete and overtake Blockbuster. This line of theorizing presupposes that positive emotions make individuals more open to and accepting of new information (Isen, 2000; Fredrickson, 2004), and reduce the likelihood of resistance, thereby boosting the chances that innovations are successful. However, the findings of this research suggest that communicating novel technological opportunities in terms of, or to elicit, negative emotions can also be an effective strategy. In the studied case, managers in TechCorp's R&D department were able to gain the attention and support of key decision-makers in the CSUs by evoking fear – a negative emotion – in them. In experiencing a fear of missing out, the CSU decision-makers were compelled to take account of and act upon the opportunity presented by QKD, to avoid the threat of competitors enjoying its benefits and being embarrassed as a consequence. Subsequently, the CSUs began engaging with the technology, as a means of addressing (i.e. avoiding) the aversive and unpleasant experience of fear they had come to experience. The notion that negative emotion is a powerful facilitator of action corresponds with research in psychology, which has found that negative emotions have stronger motivational qualities than positive emotions because their evolutionary purpose has been to alert humans to dangers and threats in their environment, stimulating behavioural adaptations that protect their wellbeing and chances of survival accordingly (Baumeister, Bratslavsky, Finkenauer, & Vohs, 2001; Fisher, 2019).

[34] As mentioned in Section 4.2 (i) and (j), whilst the communication of QKD in terms of various external aspirations was intended to evoke positive emotions, the actual consequence was that it triggered a fear response amongst the CSUs. For the purpose of a parsimonious discussion, I have therefore distinguished between their framing in terms of positive versus negative emotion, regardless of the intended outcome of their communicative efforts.

This also corresponds with Healey and Hodgkinson's (2017) assertion that in some circumstances, up-regulating negative emotion is required to facilitate innovation and change.

To understand and explain why the findings of this study diverge from the extant literature regarding how novel technological opportunities should be communicated in emotional terms, it seems necessary to consider the level of management involved. Whereas Ravasi and Schultz (2006), Rindova, Dalpiaz and Ravasi (2011), and Raffaelli, Glynn and Tushman (2019) examined how top managers framed and communicated the opportunities provided by innovation, this study reported how middle and operational managers communicated novel technological opportunities. The discrepancy in findings therefore may therefore be understood in terms of who is trying to communicate the opportunity. More peripheral managers may have to capture the attention of those above them in the hierarchy before they can set about trying to persuade them of a given idea or course of action in order to facilitate strategic action(s) (Ocasio, 1997; Shepherd, McMullen & Ocasio, 2017). Conversely, by virtue of their position atop of the organizational hierarchy, top managers demand attention members of the organization rather than having to seek it (Hambrick & Mason, 1984).

In light of the need for middle and operational managers to gain the attention of decision-makers, it is perhaps understandable why fear was an effective way to communicate QKD in the presented findings. As an unpleasant, high activation emotion that articulates threats or dangers, fear demands attention (Huy, 2002; Damasio & Carvalho, 2013), which makes it an effective at gaining the attention of decision-makers with respect to technological opportunities, as humans proactively try to avoid threats (Smith & Lazarus, 1990). Relatedly, managers – and humans more generally – are said to be loss averse (Tverskey & Kahneman, 1991), meaning that an equivalent loss is felt twice as significantly as an equal sized gain. These factors may explain why R&D managers were more successful in communicating QKD to the CSUs in terms of what they stood to lose (i.e. negative emotion) rather than what they stood to gain (i.e. positive emotion). The use of negative emotion articulated both a potential threat and a potential loss, therefore demanding attention. While top managers may also be able to communicate technological opportunities in terms of negative emotions like fear, the fact that organizational employees pay particular attention to the interpretations, behaviours and demeanour of leaders means that this could have detrimental consequences for the organization. For example, if top managers communicated in terms of or to evoke negative emotions, it could lead to negative emotional responses across the organization, with consequences for how it operates (Barsade & Gibson, 2007; Magee & Galinsky, 2008; Kish-Gephart et al., 2009; Barsade & Knight, 2015). A very real concern in contemporary workplaces is the stress and mental health of employees, which such an approach may damage.

Taking the findings of this study and prior scholarship into account, it seems that position in the organizational structure may play a role in how novel technological opportunities are communicated. For top managers, it may be possible and advisable to use positive emotions, whereas for middle and

operational managers it might be more appropriate to use negative emotions. In this respect, this study helps to elucidate how managers communicate novel technological opportunities in emotional terms, introducing the position within the organizational hierarchy as a factor that can influence what communicative strategies are most appropriate and effective. This has three implications for extant theory; first, in offering an alternative but complementary view of existing scholarship (e.g. Ravasi & Schultz, 2006; Raffaelli, Glynn & Tushman, 2019), this study extends our understanding of how novel forms of technology are emotionally communicated within organizations, drawing attention to the utility of negative emotions and their potentially stronger motivational ability than positive emotions (Baumeister et al., 2001; Hodgkinson & Healey, 2011; Fisher, 2019). Further research is still required to understand the longer-term implications or consequences of using negative emotions in this manner, though. Over time, do such strategies become less effective, as audiences become more accustomed and adapt to the 'shock factor' involved? What is the impact on the organization's emotional climate (Ashkanasy & Daus, 2002; Parke & Seo, 2017) and what are the consequences for the pursuit of technological opportunities and innovation? Equally, are there implications for employee wellbeing and mental health? These are questions which future research on the topic may seek to address.

Second, the presented findings respond to calls by Ocasio, Laamanen and Vaara (2018) for research which "[expands] the role and centrality of communication in generating changes to the firm's strategic agenda and attention structures" (p.156) by showing how communicating novel technological opportunities in terms of negative emotions like fear can not only attract the attention of top managers, but also successfully spur action around a given initiative. In this respect, the findings of this study further furnish our understanding of the politics of attempted innovation (Cyert & March, 1963; Ocasio, 1997) and show how managers may use aspirations and emotionally-laden rhetoric to communicate in a way that furthers the political interests of either themselves, their group or both.

Finally, the findings of this research progress our understanding of how organizational structure may affect the communicative tactics available to managers, showing how middle and operational managers use negative emotion as a means of gaining the attention and support of their superiors. In this way, this the findings of this study also relate to the literature on issue-selling (Dutton & Ashford, 1993; Kaplan, 2008; Mantere & Vaara, 2008; Rouleau & Balogun, 2011; Lu, Bartol, Venkataramani, et al., 2018) by demonstrating the potential efficacy of packaging issues in terms of negative emotions to influence the decisions made by organizational leaders. This corresponds with Dutton and Ashford's (1993) early work on issue-selling, which posited emotion as an important consideration in how managers communicate issues, and contributes to the re-emerging interest in the role that emotion plays in issue-selling (Ashford, Ong & Keeves, 2017; Wickert & De Bakker, 2018) by illustrating the benefits of packaging issues in terms of, or to evoke, negative emotions (cf. Grant et al., 2009; Grant, 2013), as a means of facilitating the pursuit of novel technologies.

5.2.3 *Ambivalence and indecision in the pursuit of innovation*

The findings of this research also contribute to our understanding of how mixed emotions – or 'ambivalence' (Rothman et al., 2017) – can be experienced in the pursuit of novel technologies in incumbents. Additionally, how this ambivalence may create indecision which – paradoxically – can actually facilitate the emergence of novel technologies. In this respect, this study progresses a positive perspective on ambivalence (e.g. Pratt, 2000; Fong, 2006; Plambeck & Weber, 2009; 2010), but offers a point of departure by suggesting that the mechanism through which emotional ambivalence aids the pursuit of novel technologies (and attempted innovation) may be indecision. Subsequently, the presented findings elucidate how emotion affects the decision-making and behaviour of organizational actors as they attempt to innovate, heeding calls for research on innovation and decision-making that considers cognition and emotion holistically in order to provide greater behavioural plausibility (Gavetti, 2005; Cohen, 2007; Hodgkinson & Healey, 2011).

5.2.3.1 *The experience of univalent emotional ambivalence*

Scholars have acknowledged that to the extent that pursuing novelty and innovation has implications for groups within the organization, they will trigger emotional responses (Menges & Kilduff, 2015). What emotion is experienced depends on the extent to which these technologies support or obstruct the goals or values of that group (Lazarus, 1991a). In this respect, the findings of this study show how particularly novel technologies like QKD might cause key decision-makers to experience mixed emotions, or emotional ambivalence (Ashforth et al., 2014; Rothman et al., 2017). Ambivalence refers to a state in which actors simultaneously experience positive and negative orientations towards an object (Ashforth et al., 2014), which key decision-makers are likely to experience as they try to make sense of the uncertainty associated with particularly novel technologies (Benner, 2007). Since it is difficult to know *ex ante* whether these innovations will be successful or not (Rindova & Petkova, 2007), organizational actors often imagine a range of scenarios in which novel technologies are (un)successful, as a means of trying to arrive at a decision (Wilson & Gilbert, 2005; Patvardhan & Ramachandran, 2020). In imagining a range of possible outcomes, these actors may have different thoughts and emotions. When these are opposing, they might create the sense of being torn or conflicted, which is characteristic of ambivalence.

Ambivalence is a multifaceted phenomenon. It can derive from opposing thoughts or attitudes about an object (cognitive/attitudinal); from holding opposing emotions about an object, where opposition may exist in terms of the valence of the emotion themselves (positive/negative) or the action tendencies they motivate (approach/avoid); ambivalence may also occur from a clash between cognitions and emotions (Kaplan, 1972; Conner & Sparks, 2002; Ashforth et al., 2014; Rothman et al., 2017). Generally, research on emotional ambivalence has focused on instances where those affected simultaneously experience positive and negative emotions towards an object, with opposing action tendencies (e.g. Larsen, McGraw & Cacioppo, 2001; Larsen, McGraw, Mellers & Cacioppo, 2004;

Fong, 2006). However, the findings of this study explicate a lesser-studied version of this phenomenon – univalent emotional ambivalence – where two emotions of the same valence are experienced (in this instance, fear of failure and fear of missing out). However, the behaviour that these dual fears motivated were opposing. The CSUs' fear of missing out on the opportunity that QKD represented motivated avoidance tendencies that were manifest as approaching and engaging with the technology. Simultaneously, the CSUs' fear of failing to fulfil revenue targets if they pursued the technology also motivated avoidance tendencies, but this involved withdrawing from the opportunity altogether. Decision-makers therefore found themselves torn between missing out on an opportunity, as well as not fully understanding whether or not to engage with it. In discovering that decision-makers can experience ambivalence with respect to novel technologies, the findings of this study also raise questions about extant conceptualization of how decision-makers satisfice (Gavetti et al., 2012; Posen et al., 2018). The literature assumes that actors form univalent attitudes or evaluations about objects of interest, however my findings echo Plambeck and Weber (2009; 2010) and suggest that this is not always the case, which begs the question of how actors respond to, or deal with, options in the context of feeling ambivalent about them.

Generally, the experience of ambivalence is considered to be aversive because it contravenes human consistency motives, meaning that individuals are motivated to resolve their ambivalence (Festinger, 1957; Ashforth et al., 2014). However, the findings of this study suggest that emotional ambivalence might be particularly difficult to resolve when it results from dual fears that motivate mutually exclusive action tendencies. Fear is a highly unpleasant and undesirable state that actors are predisposed to try and avoid (Frijda, 1988; Ellsworth & Scherer, 2003), but when the behaviours involved in avoiding or escaping one feared threat are mutually exclusive with another, it can become especially difficult for actors to privilege one fear and course of action over the other. Unless one fear is perhaps more prominent or imminent than the other, actors may find themselves stuck between options, knowing that promoting one fear and course of action over the other (in order to address and resolve their ambivalence) might lead to the manifestation of one of their fears. Moreover, there is no certainty that this will definitively resolve their fear, either.

In such circumstances, it is possible that ambivalence can cause indecision, where actors suffer from a reduced ability or "complete paralysis in deciding between the positive and negative aspects of the ambivalence object" (Qahri-Saremi & Turel, 2020, p.828), which can cause the decision-making process to grind to a total halt. The experience of univalent ambivalence can therefore have implications for the pursuit of novel technologies in incumbent organizations. While prior research has linked ambivalence to slowed decision-making (Sincoff, 1990; Weick, 1998; Pratt & Doucet, 2000; Rothman & Wiesenfeld, 2007; van Harreveld, van der Pligt & de Liver, 2009; Pratt & Pradies, 2011; Nohlen, van Harreveld, van der Pligt & Rotteveel, 2015; Rothman et al., 2017), this study goes further by suggesting that ambivalence may lead to a standstill in decision-making. In this manner, indecision

could be understood as a coping mechanism that actors may adopt to deal with or manage their ambivalence, when they are facing highly uncertain and ambiguous decisions that leave them unsure whether to approach or avoid the ambivalence-inducing object (Pratt & Doucet, 2000; Rothman et al., 2017; Qahri-Saremi & Turel, 2020). It might also be the case that organizational actors may opt to endure ambivalence as a strategy to protect themselves from making the 'wrong decision' in uncertain outcomes where they are not obliged to choose between options (Reich & Wheeler, 2016; Rothman et al., 2017). Indecision may therefore allow them to buy time until the correct course of action becomes apparent, or is potentially made for them. In the studied case, this would involve one fear becoming more significant. For example, one competitor actually starting to provide QKD, making their fear of missing out more significant than their fear of failure, tipping the proverbial scales in that direction. Future research may be valuable to examine whether such outcomes would emerge from univalent ambivalence stemming from two positively rather than negatively valenced emotions, to better understand the relationship and nature of ambivalence and indecision.

While the nature and consequences of indecision will be discussed in greater detail in the next section of this chapter, the fact that it may help facilitate the emergence of novel technologies in this study highlights how ambivalence can have a positive and productive effect on the pursuit of novel technologies in incumbent organizations. This study therefore supports the idea that emotional ambivalence can benefit organizational innovation, but whereas prior scholarship has suggested the mechanism through which this occurs to be heightened actor creativity (Fong, 2006), increased receptivity of managers to new ideas and changing their beliefs (Plambeck & Weber, 2009; 2010) and increased judgement accuracy (Rees et al., 2013), this study posits indecision as a possible mechanism through which ambivalence can aid the pursuit of novelty and innovation. The productive potential of indecision in the pursuit of novelty and innovation

5.2.3.2 The positive potential of indecision

In showing how emotional ambivalence can lead to indecision, which in turn might facilitate the emergence of novel technologies in incumbent organizations, this study advances recent theorizing suggesting that indecision might provide "the seed for positive outcomes" (Rothman et al., 2017, p.43).While indecision meant that the decision-making process ground to a halt in the studied case, this paradoxically facilitated the innovation process because it provided time in which the technology could further develop. The consequence was that sufficient technical and business acumen were acquired, and the capabilities required to deliver the technology began to emerge at the organization. In this manner, this study highlights the productive potential that indecision might have in the pursuit of novel technology and innovation, and advances an alternative reading of indecision as something that can be beneficial rather than inherently detrimental (cf. Charan, 2001; Denis et al., 2001).

The presented findings showed how indecision aided the emergence of QKD in the studied case by preventing decision-makers in the CSUs from being able to hastily reject the technology. This

finding is important, because research has shown that novel ideas and solutions are often rejected because they fail to conform to the economic criteria that organizational decision-makers generally draw upon to evaluate such ideas (Lu et al., 2018), which causes novel technologies and solutions to be interpreted as not valuable or meaningless by such decision-makers (March, 2010; Augier, March & Marshall, 2015). Often, though, the value of novel technologies takes time to become clear. Because indecision means that novel technologies are not outright rejected, and instead remain on the organizational agenda, it may provide the time and space necessary for this value to become more ostensive, which can increase the likelihood of the technology being accepted. As the presented findings show, during the period of indecision, QKD capabilities began emerging at TechCorp, which provided a basis from which the organization could pursue the technology. This prolonged period of time on the organizational agenda may also breed higher levels of familiarity with key decision-makers, which is important because prior research has shown that fear of the unknown and a commitment to the status quo can impede the adoption of novel technologies in incumbent organizations (Gavetti, 2005; Brusoni et al., 2020). Indecision may therefore help to mitigate such threats.

In demonstrating how indecision might facilitate the emergence of novel technological opportunities in incumbent organizations, this research puts forth an alternative and more positive perspective on indecision than prior scholarship. The idea that indecision leads to positive outcomes contravenes many long-standing assumptions in management, where it is typically assumed that good outcomes stemming from rational, thought-out decisions (March, 1994; Chapter 1), or through managers making choices quickly to capitalize on environmental opportunities (Eisenhardt, 1989b; Brown & Eisenhardt, 1997). While the extant literature that specifically investigates indecision is dispersed, having been touched on but not exhaustively investigated in domains including decision-making (Simon, 1947; Charan, 2001; Denis et al., 2011), identity (Newark, 2014) and career/vocational decision-making (Germeijs & De Boeck, 2002; Guay, Senécal, Gauthier & Fernet, 2003), it is commonly portrayed as problematic. In the context of management research in particular, indecision is deemed problematic because it prevents progress from being made. For example, scholars have reported that a lack of firm and stable decisions can undermine organizations from implementing and acting upon decisions and courses of action (Charan, 2001), while it can prevent progress being made in attempted mergers (Denis et al., 2011). Subsequently, indecision is portrayed as undesirable and something to be avoided. However, the findings of this study provide evidence that indecision can help mitigate the dysfunctions of economic decision-making (Hodgkinson & Healey, 2011), suggesting that indecision is not inherently bad (see Table 5.2 for a comparison of different conceptualizations of indecision).

Whether indecision has a positive or negative impact on the organization seems to depend on whether or not it allows some form of work or progress to be made. In the studied case, although indecision prevented QKD from making formal progress in the official innovation process at TechCorp,

indecision did not prevent R&D managers from continuing to work on and progress the QKD project further. I subsequently found that this work allowed managers to gain both technical and commercial knowledge, to the extent that they became capable of delivering the technology in the real-world. Indecision therefore helped capabilities emerging in the studied organization. However, other researchers have found that indecision prevents action and progress from taking place. For example, Charan (2001) stated that indecision prevented managers from implementing, or led to them proactively reversing, decisions made by the CEO, which stifled organizational progress in these domains. Denis et al. (2011) echoed these sentiments, stating that a lack of a firm and concrete decision in an attempted merger between three hospitals prevented the merger progressing. While some action was possible, Denis et al. (2011) reported that progress was very slow or not possible, because decisions were constantly revised and altered. Another factor which may contribute to whether or not indecision is problematic or productive might be the duration for which it lasts. Whereas indecision lasted only six months in this study, it lasted many years in the project Denis et al. (2011) studied, while indecision was said to be recurring by Charan (2001). It is permissible that indecision was beneficial in the context of this study because the innovation process was perhaps not fully in the final implementation stage (Garud, Tuertscher & Van de Ven, 2013), and so there was still technical and commercial development work to be done. However, if TechCorp were deeper into the final implementation stage, it is possible that indecision over whether or not to adopt and provide QKD to customers would have been more problematic. In this manner, the effects of indecision may be contingent on the context. In scenarios requiring fast and definitive actions – such as where first-mover advantages may exist (Lieberman & Montgomery, 1988; 2013) – indecision could quickly become problematic if progress is not possible without a firm, concrete decision. However, in circumstances where progress is possible without firm decisions – such as the more intermediary stages of the innovation process – indecision allows more reflective and deliberative thinking (Pratt & Doucet, 2000; Rothman & Wiesenfeld, 2007; Pratt & Pradies, 2011), which may facilitate capability development, and encourage more favourable evaluations by decision-makers.

In linking the experience of emotional ambivalence to indecision, this study contributes to our understanding of the nature of indecision in the strategic management of organizations by explicating the emotional factors that may be involved, something that has received relatively little attention to date[35]. While Charan (2001) alluded to the importance of emotional factors in causing or creating indecision, he stopped short of explaining the mechanisms and relationships involved. Similarly, Herbert Simon (1947) offered only a cognitive account of indecision, suggesting that indecision occurs due to a lack of information required to make decisions, but did not explicate the role that emotion

[35] It is worth noting that there are some studies in psychology that have examined indecision and its potential emotional antecedents (e.g. Reich & Wheeler, 2016; Qahri-Saremi & Turel, 2020).

might play in this process. The presented findings therefore extend Charan's (2001) and build on Simon's (1947) accounts by suggesting what the emotional consequences of uncertainty could be. Specifically, the findings show how uncertainty might contribute towards experiences of fear that could instantiate indecision. In this manner, this study heeds calls from Simon himself to consider emotion alongside cognition in theories of decision-making (Simon, 1967; 1987). Indecision is attributed to enduring emotional ambivalence caused by the aforementioned uncertainty and the action tendencies it entails. It is these opposing action tendencies which prevent decisions from being made. Thus, this research reconciles cognition with emotion, paying credence to the recursive relationship that exists between cognition and emotion (Izard, 2009; Hodgkinson & Healey, 2011), in order to offer a more holistic and behaviourally plausible account of indecision in organizational innovation and decision-making. Accordingly, this research responds to calls for research that considers the role of affect in decision-making (Gavetti, 2005; 2012; Cohen, 2007; Hodgkinson & Healey, 2011), and contributes to our understanding of both ambivalence and indecision by establishing the relationship between the two, and explaining how mixed emotions can prevent decisions from being made.

The concept of indecision that this study advances bares similarities to two other concepts in the extant literature: inertia, which is often referenced by scholars studying the challenge of innovating in incumbent organizations (e.g. Tripsas & Gavetti, 2000; Gilbert, 2005; Benner, 2009; Danneels, 2011; Zuzul & Tripsas, 2020), as well as Tversky and Shafir's (1992) notion of deferred decision-making. Thus, it is worth briefly distinguishing between these concepts. Deferred decision-making refers to situations in which "actors [decide] not to decide" (Kaplan, 2008, p.733) and thus a decision will have been made; however, in this study, no such decisions were ever reached through the indecisiveness (i.e. indecision) of managers in TechCorp's CSUs. Accordingly, these were not deferred decisions as no decision was made. Similarly, whilst inertia concerns a lack of energy or impetus for change (Gavetti & Porac, 2018) the concept of indecision involves an abundance of energy, but its existence is not sufficiently focused in the direction of an innovation or change initiative, which means that ostensive progress or change do not manifest. Despite the sparse nature of research on indecision, this distinction based on the level of energy involved corresponds with the ideas of Newark (2014), who in exploring how indecision affects identity, proposed that indecision was "a state in which a decision-maker is attempting to make a decision" (p.165) and thus implies activity and the existence of energy. The aforementioned study of Denis et al. (2011) also implied the existence of energy for change from the three parties involved, but that the lack of clear direction of this energy prevented progress from being made. Notably, this distinction between inertia and indecision has implications for our understanding of the process through which novel technological opportunities are pursued in incumbent organizations. Whilst the early stages of this process may involve overcoming inertia by creating an impetus for change, an idea that is evident in the literature on organizational change with Lewin's (1951) principles of unfreezing, moving and refreezing, the latter stages of this process may be better understood as a

process of navigating and harnessing different energies in such a way that they can have a productive impact and lead to desired outcomes. From the outside the organization may appear to be inert because there is little apparent movement or progress, but this is not necessarily through a lack of energy or trying within the organization. Such a position is in line with the political perspective espoused by behavioural theorists (e.g. March, 1962; Cyert & March, 1963; Pfeffer & Salancik, 1974; Pfeffer, 1981; Ocasio, 1994; 1997; Kaplan, 2008; Zhang & Greve, 2019; Mithani & O'Brien, 2021), in which the need to establish and mobilize support is a crucial determinant of whether or not forms of change will prove successful in organizations.

	Simon (1947)	Charan (2001)	Denis et al. (2011)	This Study
Definition	*"If rationality is to be achieved, a period of hesitation must precede choice, during which the behaviour alternatives, knowledge bearing on environmental conditions and consequences, and the anticipated values must be brought into the focus of attention"* (p.101)	*"A misfire in the personal interactions that are supposed to produce results [means] the people charged with reaching a decision and acting on it fail to connect and engage with one another… Lacking emotional commitment, the people who must carry out the plan don't act decisively."* (p.110)	*"Situations in which people and organizations continually make, unmake, and remake strategic decisions, resulting over the long term in a large expenditure of energy with little concrete strategic action, the constant possibility of reversal or reorientation, and potential widening scope of decision activity."* (p.225)	*A period which occurs as a consequence of enduring or unresolved emotional ambivalence towards a technological opportunity, which prevents a commitment being made to either pursue or reject the opportunity.*
Context	Decision-making in organizations	Implementing CEO decisions in private organizations	Episodes of collaborative decision-making in large, publicly funded projects	Decision making in incumbent organizations regarding whether to pursue or reject novel technologies
Core Assumptions	Indecision is an antecedent period before a decision is made, which occurs due to a lack of information required to arrive at or make a rational decision. Indecision is therefore cognitive in nature.	A lack of social mechanisms for debate and dialogue result in managers becoming ambivalent or overtly resistant towards CEO decisions. This lack of emotional commitment to courses of action means managers avoid implementing, or proactively undo, CEO decisions. Indecision is problematic because it prevents organizations from making progress.	Pluralistic settings, characterised by diffuse and dynamic power relations, a lack of clear leadership and uncertainty over the potential-vs-real availability of resources. Prolonged time horizon (multiple years) where decisions are continually (un)made prevents stable decisions or commitment. Indecision is therefore problematic as it inhibits progress from being made.	Indecision is caused by emotional factors: high levels of uncertainty and ambiguity may contribute to unresolvable or enduring ambivalence, which can cause or be managed through indecision. Periods of indecision can last many months, but may not be problematic because work can continue on novel technological projects if resources continue to flow. Indecision may therefore benefit novel technological opportunities by affording them time and space to continue developing and maturing.

Figure 5.2 - Comparison of different conceptualizations of indecision in the literature

By showing how ambivalence and indecision can have a positive and productive effect on incumbent organizations pursuing novel technological opportunities, these findings also have a number of implications for the literature on the micro-foundations of dynamic capabilities (Hodgkinson & Healey, 2011; Teece, 2014; Helfat & Peteraf, 2015; Helfat & Martin, 2015). If being able to endure emotional ambivalence and states of indecision offers benefits to incumbent organizations seeking to pursue novel forms of technology, then there may be advantages to managers and organizational actors who are more capable of dealing with this aversive experience. This emboldens the importance of managerial emotional capabilities (Huy, 1999; 2002; Hodgkinson & Healey, 2011; Huy & Zott, 2019), and suggests that a valuable characteristic or capability is to be emotionally robust and capable of regulating emotional states (Gross, 2015) like ambivalence, in order to be able to cope. This corresponds with recent suggestions by Huy and Zott (2019) and Vuori and Huy (In-Press) who have accentuated how actors involved in the strategic management of the firm need to be able to manage and modify both their own emotions, as well as being able to regulate the emotions of others. The idea of being able to withstand or sustain ambivalence also corresponds with assertions made by Ashforth et al. (2014), who suggested that embracing ambivalence was a way in which wisdom could be ascertained and imparted on organizations, allowing better decisions to be made through dialectical reasoning. Finally, since the state of ambivalence and indecision in the studied case was caused through the communicative efforts of middle and operational managers in TechCorp's R&D department, it underscores how the communicative capabilities of managers (Agarwal & Helfat, 2009; Taylor & Helfat, 2009; Helfat & Peteraf, 2015; Ocasio, Laamanen & Vaara, 2018) may play a critical role in both emotion regulation and subsequently the innovation process, by helping to (re)configure and orchestrate human assets in a way that allows novel technological opportunities to be capitalized upon.

5.3 Managerial Implications

Based on the findings of this study, there are a number of implications and practical recommendations available for managers. The major implication of this study is that the pursuit of novel technological opportunities and innovation can be affectively-charged, and that it is unnecessary and arguably inappropriate to marginalize emotions. Ultimately, emotions are a source of information that managers can draw upon and scrutinize to become more rational in their decision-making, given notions of intended rationality are premised on considering as much information as possible in making choices. Particularly, different aspects of the innovation process are likely to be characterised by different emotions; for example, the initial discovery or uncovering of a high-potential novel idea might trigger intensely positive emotions like awe or excitement in some, and perhaps fear or anger in others. Similarly, latter stages where firm decisions are going to be made may be characterised by mixed emotions (ambivalence) and thus managers ought to acknowledge these emotions and reflect why they are experiencing them, as a means to understand what sorts of biases this may introduce to their thought processes and potential actions. As such, there might be scope for further education and development

of managerial emotional capabilities, in terms of the emotion process (i.e. how they are elicited, experienced and what they mean) and an understanding of what action tendencies are associated with different emotions. Building this level of understanding may allow managers to take emotions into account and make more informed decisions accordingly. Equally, there would be value in the development of emotion regulation skills, which could allow managers to manage the emotions of themselves and others in order to support desired outcomes. Ultimately, the findings of this study reinforce that emotion is a crucial aspect of the innovation process, but receive limited attention or consideration in organizations currently. Treating emotions seriously may therefore be an avenue through which organizations can unlock competitive advantages over competitors.

Relatedly, a recent trend in management practice has been the normalization of failure, an idea which stems from the school of thought that fear of failure has a paralysing effect on individuals and groups and therefore is best avoided. Whilst fear of failure might have this effect in some circumstances, the findings of this study indicate how such a blanket approach to failure may result in organizations missing out on some of the productive effects and outcomes that fear can contribute. It seems possible that without their experience of fear of failure, the R&D department at TechCorp might have given up on QKD and the organization might have missed out on the opportunity. Instead, their fear of failure motivated efforts to articulate the opportunity and generate support for it. Whilst this was not successful to the extent it was immediately accepted, decision-makers came to understand and appreciate the opportunity, keeping it on the organizational agenda for longer. More time can often be all that novel technologies need, as their purpose and value becomes clearer. In this manner, fear acts as a double-edged sword, and although managers may need some affirmation that failure will not be fatal, value remains in failure being seen as consequential.

How managers communicate novel technological opportunities is obviously a pivotal task in incumbent organizations, in order to help facilitate innovation and change, and to ensure that the organization is viable in the short- and long-term. The findings of this study suggest that how novel technologies and solutions are most appropriately communicated may depend on the level of hierarchy that managers find themselves in, (i.e. their position in the organizational structure). Top managers may be able to convey novel technological opportunities in terms of positive emotions and opportunity frames because by virtue of being top managers, they naturally demand and attract the attention of other organizational employees. Therefore, the purpose of their communication centres around garnering support. Conversely, more peripheral middle and operational managers may not have this luxury, and must grab the attention of their superiors, which is finite. Articulating opportunities in terms of threats or potential losses (i.e. negative emotions) might be a more effective strategy to gain attention, because humans are loss averse and therefore more likely to pay attention to innovations that they stand to lose, than those they stand to gain.

Similarly, when managers need to communicate across discrete business units or divisions which have their own cultures and goals, articulating opportunities in terms of organizational goals and reference points can be an effective way of finding a 'common ground' and conversing in terms that the target audience understand and consider to be legitimate. However, one thing that managers need to be aware of is that more is not always better. Although intuitively communicating a technological opportunity in terms of a multitude of goals or outcomes that it can help achieve or fulfil would make it appear more valuable and desirable, doing so may also evoke ambiguity on the matter, which can stymy progress and prevent decisions from being made. Undoubtedly there might be situations in which the strategic elicitation of ambiguity is the desired outcome, and thus this may be a more useful or effective communicative strategy. However, in circumstances where managers wish to succinctly convey the value of a novel technological opportunity this seems unlikely to be helpful.

While indecision may conventionally be seen as undesirable and unavoidable, in some eyes the sign of a poor manager, this study suggests that periods of indecision can be fruitful for incumbents pursuing novel technological opportunities. Thus, portraying indecisiveness as an undesirable is perhaps short-sighted. Taking time to reflect on ideas rather than making immediate decisions can afford managers the opportunity to engage in more deliberative thinking on matters which can lead to an improved understanding, as well as potentially preventing them from making 'wrong' decisions (i.e. accepting a bad idea, rejecting a good idea) by allowing uncertainty and ambiguity to resolve and the value of such opportunities to become clearer. This also spares them the need to make predictions about distant and uncertain futures. That said, this is not an attempt to diminish the role of anticipation and strategic foresight. Undoubtedly, there are situations in which foresight allows organizations to get a jump on the competition, and there will be circumstances in which indecision is not an option or is outright detrimental. This idea is broadly. consistent with the trend towards organizations being a 'fast second' rather than first to enter nascent markets, and may be particularly relevant to incumbents with little to no slack resources as a means of mitigating the risk of a failed project.

One of the major difficulties observed in this study was the transition of novel opportunities from exploratory to exploitative business units, an issue which has been commonly reported in many incumbents seeking to innovate outside of their core business. Despite incumbent organizations being well-placed to develop and deliver novelty to the marketplace, they often stumble when it comes to delivery (i.e. commercialization). This study suggests that at the heart of this issue are distinct organizational goals and a lack of incentive for exploitative divisions to allocate their finite resources towards long-term and prospective innovations. These can cause distinct appraisals of novelty to be made that differ from those made in exploratory business units. Accordingly, novelty may be better able to cross the chasm between exploratory and exploitative business units if managers in exploitative units are given organizational imperatives relating to the introduction of long-term, prospective technologies into their portfolios of products and services they offer customers, which would help to

encourage them to operate outside of the short-term. Similarly, a reconsideration of what exactly constitutes 'rational' may be worthwhile; emotion and intuition are both legitimate ways in which actors can think, and if considered can help managers to arrive at a more truly 'rational' decision, if rationality is taken to mean considering all available alternatives and information, within reason. Indeed, accepting less objective sources of information – such as emotion and intuition – is important with respect to novel technologies: novelty will never make rational sense to begin with, because by definition it is different and unproven and therefore liable to undermine existing resource streams and cannibalize extant resource and knowledge bases.

6 Conclusion

This research set out to explore the challenges that incumbent organizations face in commercializing novel technologies and solutions, in order to deliver novelty to the marketplace. Through a 24-month case study of QKD at TechCorp studied using a grounded ethnographic approach, I explored how this challenge was navigated, following the (inter)actions of two key groups involved in TechCorp's pursuit of novel technological opportunities, the R&D department (exploratory) and CSUs (exploitative). I paid particular attention to how more peripheral middle and operational managers communicated novel technological opportunities to decision-makers as they attempted to capture their attention and support, while also examining the role that emotions played throughout the innovation process. This thesis therefore develops an emotional perspective on how incumbents pursue novel technologies, building and developing the cognitive perspective which has dominated prior research and marginalized or remained devoid of emotion.

From an affective perspective, the pursuit of novel technological opportunities appears to be characterised by the experience of various positive and negative emotions, but central to this are distinct forms of fear which have their own unique motivational dynamics. The managers involved in the pursuit of novel technological opportunities must navigate high levels of uncertainty and ambiguity, which can contribute to fear of failing to meet specified goals or outcomes (fear of failure), or potentially missing out on strategic opportunities to competitors, and the potential embarrassment this entails (fear of missing out). Despite prior studies asserting that fear is an impediment to the exploration of novel technological opportunities and innovation (cf. Vuori & Huy, 2016; Zuzul, 2019; Brusoni et al., 2020), fear can be productive, to the extent that it focuses attention on issues that threaten the emergence of novel technologies, and may motivate actions to remedy these issues, such as efforts to communicate these opportunities as viable and desirable to gain attention and build support for them, in order to facilitate their pursue. This seems likely to occur when novel technologies are seen as a way to escape a feared threat. The discovery of fear of missing out is particularly exciting, given its prevalence in popular literature and the media, with this study providing evidence that it could behave as a key mechanism for overcoming incumbent inertia.

A challenge that managers in exploratory business units – who are responsible for identifying novel technologies for potential commercialization – face is to convince their counterparts in exploitative business units – who are responsible for generating revenue – to accept and pursue novel technologies and solutions. The use of aspirations may therefore be an important rhetorical tool that managers can use to ensure they communicate in a way that is understood and resonates with managers in other departments (Elsbach & Kramer, 2003; Giorgi, 2017), which is critical to develop understanding of such opportunities and a basis from which positive sentiment might be established. However, middle and operational managers who are responsible for driving technologies across the chasm between exploratory and exploitative business units may also need to communicate these

technological opportunities to evoke negative emotions (cf. Raffaelli, Glynn & Tushman, 2019) if they are to gain the attention and support of key decision-makers. When these opportunities are communicated in terms of positive emotions, these managers can be dismissed as emotional and irrational, however the use of negative emotions like fear demands the attention of organizational actors and is less easily dismissed, due to the fact that humans are averse to both threats and losses (Tversky & Kahneman, 1991; Baumeister et al., 2001). In these scenarios, it seems important that technological opportunities are established as the solution to these negative emotions or problems, to maintain this air of escape and positive sentiment.

Although many assume that the pursuit of novel technological opportunities might culminate in a tidy, clear-cut decision to pursue of reject, incumbent organizations may in fact end up pursuing such opportunities somewhat subconsciously. The uncertain and ambiguous nature of novel technological opportunities means that organizational decision-makers may well experience ambivalent (Rothman et al., 2017) thoughts and emotions regarding whether or not to accept or reject them. Decision-makers are prone to experience both a fear of failure and a fear of missing out, as they imagine scenarios in which the technology is successful and unsuccessful. The high levels of uncertainty and ambiguity involved may subsequently make it difficult for decision-makers to arrive at firm decisions, and instead can cause indecisiveness and indecision. While indecision may prevent the official progression of novel technologies through the incumbent innovation process, when the flow of resource towards such projects remains uninterrupted, indecision can allow work to continue on these projects. Accumulating time, experience and understanding of such technologies can lead to the development and emergence of capabilities within organizations, as sufficient technical and commercial knowledge is ascertained to offer them to real-world customers. In this respect, emotion can help to facilitate the pursuit of novel technological opportunities in incumbent organizations, whether managers are consciously aware of the fact or not.

6.1 Summary of key theoretical contributions

The major contribution of this study is to provide an affective account of the pursuit of novel technology and innovation in incumbent firms, addressing calls by a multitude of scholars to consider how emotion affects organizational decision-making and innovation (Gavetti, 2005; Cohen, 2007; Gavetti, Levinthal & Ocasio, 2007; Hodgkinson & Healey, 2011; Gavetti et al., 2012; Vuori & Huy, 2016). In this respect, this study shows how fear can be productive as well as destructive in this process (cf. Vuori & Huy, 2016; Brusoni et al., 2020), motivating actions – such as communicative attempts to emphasise these technologies as viable opportunities – that might help to facilitate their pursuit. Additionally, this study suggest that may exist in different forms – fear of failure and fear of missing out – which may have implications for how organizational processes may be designed and managed. Subsequently, this thesis helps to provide a more balanced view on the role of fear in the pursuit of

innovation as something that is not inherently good or bad, supporting and extending the contingent perspective as advised by Lebel (2016; 2017). This brings our understanding of fear in the pursuit of novel technologies in line with how it has been conceptualized by entrepreneurship and psychology scholars (Conroy, 2001; Conroy & Elliot, 2004; Conroy & Coatsworth, 2004; Mitchell & Shepherd, 2011; Cacciotti & Hayton, 2015; Cacciotti et al., 2016; 2020). Furthermore, this thesis introduces the novel concept of fear of missing out to the literature on innovation, and explicates its potentially powerful motivational characteristics. This thesis therefore improves our understanding of how organizations could be designed and managed in order to harness the power of emotions (Gavetti et al., 2012). In the process, this thesis also raises question marks over the tendency to normalize failure in organizations (Danneels & Vestal, 2020), and nuances our understanding of the process of benchmarking and use of social aspirations (Greve, 1998; Hu et al., 2017) in terms of their potential emotional consequences.

The second major contribution of this thesis is to expound the communicative strategies that middle and operational managers may use during the pursuit of novel technologies. It therefore builds on and develops prior research regarding how novel technological opportunities are communicated (e.g. Ravasi & Schultz, 2006; Giorig, 2017; Raffaelli, Glynn & Tushman, 2019) and differentiates how middle and operational managers may engage in this task in comparison to top managers. Specifically, it shows how top managers may seek to communicate in terms of positive emotions because they do not need to capture the attention of the audience by virtue of their hierarchical position (Magee & Galinsky, 2008), whereas middle and operational managers must communicate in terms of negative emotions like fear, in order to garner the attention and support of key decision-makers. Additionally, the findings of this study show how these managers may use aspirations (Shinkle, 2012) to communicate technological opportunities in order to build understanding and support, as aspirations are construed as legitimate values by organizational actors. This can help managers to communicate across departments that have their own guiding logic and corporate goals. In this manner, this research extends our understanding of aspirations outside of the context of performance feedback (Gavetti et al., 2012), and responds to calls by Ocasio, Laamanen and Vaara (2018) to investigate how managers use communication and rhetoric in a political fashion, helping to explicate how communication can be used to manipulate the attentional dynamics in incumbent organizations.

The third major contribution of this study is to explain how emotional ambivalence and indecision may affect the pursuit of novel technology in incumbent firms. In doing so, this study highlights the productive outcomes ambivalence and indecision can lead to, furthering the positive perspective on ambivalence (Pratt, 2000; Fong, 2006; Plambeck & Weber, 2009; Rothman et al., 2017), and introducing a more positive perspective on indecision too (cf. Charan, 2001; Denis et al., 2011). Specifically, this thesis develops our understanding of univalent emotional ambivalence, an under-studied form of the phenomenon, while also introducing indecision as an alternative mechanism through

which ambivalence might positively impact the pursuit of novelty and organizational innovation (Rothman et al., 2017). In showing how emotional ambivalence may cause indecision, this thesis helps to develop our understanding of the emotional factors that contribute towards indecision, building on the assertions of Charan (2001). This also extends Simon's (1947) work on indecision, which linked indecision to uncertainty (i.e. a lack of information – Milliken, 1987; Townsend et al., 2018), by unpacking the possible emotional consequences and subsequently identifying the mechanisms responsible. While the idea that indecision can be beneficial contravenes extant research (e.g. Charan, 2001; Denis et al., 2011), this thesis helps to outline some of the factors which may determine whether or not this is the case. Namely, whether indecision prevents action and progress, as well as the duration for which indecision lasts. Periods of indecision might help decision-makers become more familiar with novel technologies and solutions, and address biases that they might hold about them. Equally, they can afford these technologies the time to be further developed and understood, to the extent that capabilities may develop, which allows the organization to provide the innovation in the real-world.

Given these first three areas of contributions, this thesis also helps to advance our understanding of how emotion can affect group functioning in organizations (Barsade & Knight, 2015; Menges & Kilduff, 2015; Vuori & Huy, 2016). Emotions like fear might motivate managers to interact with key decision-makers in such a way that is consequential for the actions that the organization takes. One can speculate that without their experience of fear, the R&D middle managers at TechCorp may not have opted to engage with their counterparts in the CSUs, which underscores how emotion is consequential for the functioning of groups within the organization. In this respect, this thesis generally advances a more behaviourally plausible account of organizational innovation and decision-making by explaining how emotion affects the cognitive processes of managers and decision-makers (Gavetti, 2005; 2012; Cohen, 2007; Hodgkinson & Healey, 2011). Prior work has offered solely cognitive accounts and explanations of decision-making, strategy and innovation, but remained "crippled emotionally, and thus detached from the emotional and visceral richness of life" (Loewenstein, 1996, p.289). Following in the footsteps of Vuori and Huy (2016), this study is therefore a step towards a more comprehensive behavioural perspective that accounts for evidence in psychology regarding the recursive relationship between the cognition and emotions of actors (Elfenbein, 2007; Scherer & Moors, 2019).

6.2 Limitations & Future Research

A limitation of this study concerns the use of the qualitative case study method taken, which may be critiqued in terms of its ability to definitively claim causal relationships. This is because it is difficult (if even possible at all) to control for all critical variables in the same way as, for example, a laboratory experiment. In this manner, causality may only be inferred opposed to definitively claimed. However, it is important to note that such an approach to causation is accepted in critical realist investigation, which informs the ontological and epistemological underpinnings of this research. Critical realists

recognize that causality in positivist terms (i.e. constant conjunction and correlation – Event A leads to Event B [Brady, 2003]) is not possible in the open systems that social scientific research occurs in (Bhaskar, 1979). Instead, critical realist research asserts that "causation can be thought of as a process involving the mechanisms and capacities that lead from a cause to an effect" (Bennett & Elman, 2006, p.457). Single case study research – like this study – is advantageous in this endeavour, because it is possible for the researcher to become embroiled in thick description and develop a detailed understanding of the case (Collier, Brady & Seawright, 2004, Chapter 13; Maxwell, 2004; Modell, 2009; Tsang, 2013). This enables researchers to form tentative context-sensitive, causal explanations of phenomenon by uncovering "traces of hypothesized causal mechanisms" (Maxwell, 2004; Bennett & Elman, 2006, p.459), which are then assessed to determine which is the most likely or suitable, based on the extent to which their data corresponds with proposed explanations (Wynn & Williams, 2012). In this respect, while I cannot definitively claim causation in this study, the explanations provided in this study constitute these hypothesized causal mechanisms developed through thick data; are supported by multiple sources of data (i.e. assertions are triangulated); and through member checking, corresponded with participants own experiences (i.e. participants believe a relationship existed and certain events/actions led to certain outcomes). However, this does not mean there could be other unidentified mechanisms at play. Thus – as with any critical realist research – I recognize that these causal explanations are inherently tentative and fallible, and are subject to being updated in light of new and disconfirming information. This offers a potential avenue to conduct further research using more quantitative methods, to determine the veracity of the developed model in a more controlled environment where constant conjunction of events is possible, and causal links can be more definitively established.

Furthermore, the ability to study emotions qualitatively also has its challenges (as discussed in detail in Section 3.8.5.2), because there is a typical reliance on self-reports that are subject to bias or misinterpretation (Kouamé & Liu, 2021). Although everything was done to ensure the accuracy of insights regarding the experience of fear through multiple method triangulation, it is still not possible to say with absolute assurance that all instances of reported fear were indeed fear. Future investigations may therefore benefit from adopting a mixed method design to studying emotions, whereby the strengths of qualitative and quantitative approaches are combined to provide greater assurances about the nature of emotions experienced.

Another limitation is the single case study research design that was adopted. While single cases generate rich insights, these are context-specific, which raises questions about the generalizability of findings past the studied context (Lincoln & Guba, 1985). However, there are number of features of the studied case which suggest that the findings will generalize to other incumbent organizations seeking to pursue particularly novel technologies and solutions. First, the fundamental issue that was investigated was the desire to pursue a particularly novel innovative technology which fell outside of

the organization's core business. This is a challenge that afflicts the majority of contemporary businesses, and thus is likely to surface similar concerns. In this respect, the multidivisional and differentiated organizational structure where exploratory and exploitative functions are housed separately is commonly used by organizations as a way of balancing incremental and more radical forms of innovation. Accordingly, it is likely that similar dynamics will arise, and divergent appraisals of novelty will be made owing to distinct corporate goals. It is permissible that this dynamic may even arise in innovation *between* organizations, where the exploratory function is fulfilled by a third party. As the pursuit of corporate goals is another common feature of contemporary organizations, fear of failing to achieve these is likely to be commonplace, meaning we can reasonably expect fear of failure to emerge in scenarios where organizations are struggling to innovate. Additionally, social comparisons have become an everyday feature of business in the 21st Century, particularly given communications technology affords insights into what others are doing very readily. This means that fear of missing out is liable to manifest, as firms compare themselves to others who are similar, or perhaps who they aspire to be like. We also know that while incumbents may desire innovation, managers often find it difficult to sign off on such courses of action for fear of failure and repercussions. The mix of accountability and the uncertainty around novel technologies means that managers often feel mixed or ambivalent and subsequently can be indecisive, opting to only make a firm decision only when it becomes clearer what the outcome is likely to be. In this regard, the experience of emotional ambivalence and indecision is unlikely to be an idiosyncratic feature of this case, but rather a more pervasive feature of pursuing novelty in incumbent settings.

Irrespective of the likely transferability of the study's findings, there would be merit in investigating how emotions affect the pursuit of novelty in alternative settings. For example, would the described process unfold in the same way in an undifferentiated incumbent organization, where innovation and commercial responsibilities are shared by the same groups (i.e. integrative ambidexterity)? Equally, what would happen if the incumbent organization was a not-for-profit, or a public- rather than private-sector organization whose dominant logic was not an economic, profit-making motive? It seems likely that such circumstances may alter the appraisals of novel technologies and therefore may lead to alternative emotional dynamics manifesting. One could also speculate that in an environment where the consequences of failure were known and perhaps not particularly significant, managers may suffer less from indecisiveness because they would suffer less from an inhibitory fear of failure. It is also possible that in an under-performing or failing organization, fear of missing out could be exacerbated. Another factor worth considering is the extent to which prior experiences of missing out influence the experience of fear of missing out.

Another limitation of this study is that data collection ceased before the success of the project was known. While TechCorp had begun to pursue QKD at the point where I exited the field, it remained unclear whether or not it had become a commercial success, and this outcome is unlikely to be known

for another number of years still. If QKD transpired to be a failure, then the theoretical model might need revisiting in order to reflect this fact. Accordingly, further data collection and an increased period of study would be required, but given the time and resource limitations associated with a doctoral degree, this was not permissible for this thesis. Assuming that QKD proves to be a success at TechCorp, future research may therefore benefit from looking at the emotional dynamics of *failed* pursuits of novel technologies and solutions.

As the level of analysis in this study was the group-level, some of the nuances and intricacies in opinions and emotions at the individual level were lost for the purpose of a parsimonious story and explanation. While the emotions of group members generally cohere (Menges & Kilduff, 2015), there is always likely to be some deviation from the norm. This uniqueness is interesting to understand, but is unfortunately lost when emotion is examined at the group level. Future research that explores the pursuit of novel technological opportunities in incumbent organizations may therefore seek to utilize multiple levels of analysis to explicate the link between the individual and group levels of emotion.

Given the theorizing regarding how hierarchical position may affect how novel opportunities are best communicated provided in the discussion of this thesis, future research may investigate and test the proposed relationships. In this respect, the use of quantitative and experimental methods may be helpful. Alternatively, a qualitative approach might make use of a multiple case study design (Eisenhardt, 1989a; Eisenhardt & Graebner, 2007) and examine how novel opportunities are communicated in organizations with a traditional hierarchical structure versus a flatter organizational design. Relatedly, future research might examine at what point in time indecision become problematic for incumbent organizations? Is it simply context-dependent, or is there a period of time after which its effects are more detrimental than beneficial? It would also be useful to understand the effects of indecision at different stages of the innovation process (e.g. ideation, implementation). Since indecision has received relatively scant attention in the management literature to date, additional research seems like a fruitful way of further enhancing our understanding of organizational decision-making.

Given that this study focuses on fear, a negative and unpleasant emotion (Lazarus, 1991a), future research may seek to identify further forms of fear, and explicate what motivational and behavioural dynamics these instantiate. Fear of failure and fear of missing out have both become common parlance in the media, but it is possible that other forms of fear exist as well. Relatedly, this study indicates that positive emotions are less prevalent in the incumbent innovation process. Why is this the case? Fisher (2019) surmised that positive emotions are generally under-explored in comparison to negative emotions in both psychology as well as management, and it would be interesting to know exactly why this is the case. Is it because – as Fisher (2019) alludes to – the diffuse nature of action tendencies associated with positive emotions makes them less helpful in achieving organizational outcomes? If this is the case, then why has there been such an emphasis on cultivating positive emotions as a means to achieving desired outcomes by management scholarship?

In conclusion, as Vuori and Huy (2016) stated, “no theory in management research could be expected to explain all of the variance observed” (p.43). This thesis sought to explain how some organizations are able to overcome the challenge of incumbency and successfully innovate, focusing on the role that emotion plays in this process, as well as how the communicative efforts of managers contributed towards this process. Alternative theoretical explanations are certainly permissible; however, this thesis advances a more coherent and holistic account of organizational innovation by reconciling cognition and emotion. In doing so, this thesis emphasises the importance of the emotions that groups experience in the innovation process, and illustrate how this can impact what decisions the organization makes, and what actions they take. Accordingly, this thesis shows how emotion affects the innovation process in large, established organizations.

7 Appendices

7.1 Appendix 1 – Ethical clearance

The Secretariat
University of Leeds
Leeds, LS2 9JT
Tel: 0113 343 4873
Email: ResearchEthics@leeds.ac.uk

UNIVERSITY OF LEEDS

Chris Golding

Management Division

University of Leeds

Leeds, LS2 9JT

ESSL, Environment and LUBS (AREA) Faculty Research Ethics Committee University of Leeds

19 September 2018

Dear Chris

Title of study: **Ecosystem orchestration in practice: An investigation of power in the emergence of the Quantum Key Distribution ecosystem**

Ethics reference: **AREA 18-007**

I am pleased to inform you that the above research application has been reviewed by the ESSL, Environment and LUBS (AREA) Faculty Research Ethics Committee and following receipt of your response to the Committee's initial comments, I can confirm a favourable ethical opinion as of the date of this letter. The following documentation was considered:

Document	Version	Date
AREA 18-007 Ethics_Form_Amended_Sept_2018.doc	2	19/09/18
AREA 18-007 CG Response to Comments.docx	1	19/09/18
AREA 18-007 Example_recruitment_email.docx	1	28/08/18
AREA 18-007 Participant_info_sheet_AMENDED.docx	2	19/09/18
AREA 18-007 Consent_Form_AMENDED.doc	2	19/09/18
AREA 18-007 Research_Methods_to_Questions.docx	1	28/08/18

AREA 18-007 Signed_NDA_Sept_2017.pdf	1	28/08/18

Please notify the committee if you intend to make any amendments to the information in your ethics application as submitted at date of this approval as all changes must receive ethical approval prior to implementation. The amendment form is available at http://ris.leeds.ac.uk/EthicsAmendment.

Please note: You are expected to keep a record of all your approved documentation and other documents relating to the study, including any risk assessments. This should be kept in your study file, which should be readily available for audit purposes. You will be given a two week notice period if your project is to be audited. There is a checklist listing examples of documents to be kept which is available at http://ris.leeds.ac.uk/EthicsAudits.

We welcome feedback on your experience of the ethical review process and suggestions for improvement. Please email any comments to ResearchEthics@leeds.ac.uk.

Yours sincerely

Jennifer Blaikie

Senior Research Ethics Administrator, the Secretariat

On behalf of Dr Kahryn Hughes, Chair, AREA Faculty Research Ethics Committee CC: Student's supervisor(s)

7.2 Appendix 2 - Participant Information Sheet

Participant Information Sheet (01/01/2020)

Exploring the pursuit of novel technological opportunities in incumbent organizations

I invite you to take part in my study that forms part of my PhD. Before deciding, I want you to understand why the research is being conducted, and what it involves on your behalf. Please read the following information about the study carefully, ask any questions you might have, and take the time to decide whether or not you wish to take part.

What is the purpose of this study?

This research is part of my PhD in Strategy, Technology and Innovation Management. The aim of the research is to explore the managerial challenges and implications for commercialization of novel technologies and innovations by incumbent organizations, and ultimately to develop theory that better explains commercializing as a process. Theory assumes that incumbents are precluded from pursuing novel ideas, technologies and innovations due to institutionalized routines and norms which they threaten to disrupt. However, the pursuit of quantum key distribution (QKD) at TechCorp suggests that these challenges can be navigated. By following the journey of QKD at TechCorp, I seek to explain how incumbent organizations are able to pursue novelty by explicating the social and cognitive (i.e. socio-cognitive) behaviours and processes they engage in as they attempt to commercialize this technology.

Why have I been invited?

You have been invited to participate in this study for one of the following reasons:

a) You have been approached by the researcher directly because you are directly involved in QKD or innovation commercialization at TechCorp or partners;
b) You have been suggested as a suitable participant for this study by another participant (what we call snowball sampling); or
c) You work within or around the areas of QKD/Quantum Technologies or encryption.

Do I have to take part?

No, participation is completely voluntary – it is up to you to decide to join the study. If you agree to take part, you will be asked to sign a consent form. You will be able to withdraw from the study without giving a reason **up to 4 weeks after you have provided data**. You can withdraw or ask questions by contacting me at christopher.c.golding@durham.ac.uk.

What will participation involve?

If you agree to take part in the study you will be asked to sign a consent form. Participation will involve taking part in one-to-one or possibly group interviews with the researcher, and providing information and experiences that are relevant to the topic being researched.

Participation might also involve being observed by the researcher while you are working. These observations will vary in length, depending on what is being observed, but most observations will be non-invasive observations of interactions, discussions and decisions within meetings during the course of your natural working day. Typically, the researcher will write field notes and not participate, although they might ask questions for clarification in some circumstances (usually after the meetings so as not to disrupt discussions).

Semi-structured interviews will last approximately 60-90 minutes. They will be audio-recorded using an encrypted Dictaphone and transcribed for analysis, after which point the audio file will be destroyed.

All of the data collected will be stored securely at the University of Durham and will be completely anonymous: any names or identifying features will be removed from the data collected.

What are the possible disadvantages and risks of taking part?

It is anticipated that there are no direct risks in taking part in this study, as the study strives to protect your identity and I do not require personal sensitive information. Although it is highly unlikely, if at any point during interviews you become distressed, the researcher will halt the interview without question. No one is informed if you personally participate or if you withdraw. This knowledge is between you and I, unless of course you choose to tell people you participated.

What are the possible benefits of taking part?

There may be no direct benefits to you as a result of participating in the study, although many people find expressing their personal experiences beneficial during interview and enjoy participation in research.

That said, the information gathered from this study will be beneficial to academics, practitioners and policy makers, serving to explicate on the processes of ecosystem emergence and orchestration; contributing towards the commercialization of QKD; and informing how complex innovations might be commercialized through the use of ecosystem forms.

Will my taking part in the study be kept confidential? What will be done to ensure anonymity?

All information gathered will be handled carefully, but **not confidentially**. The data collected will be used as part of a Doctorate Thesis and therefore publicly available, and it is anticipated it will also be presented at academic conferences and published in academic journals.

However, to be clear, the data will be **anonymised**. This means that all identifiable features will be removed to protect your identity. In the context of the research, you will be given a pseudonym. This will allow the researcher to remove your data from the research should you request them to do so.

All data will be stored on encrypted computers at the University of Durham. Audio-recordings of the interview will be made using an encrypted Dictaphone. These interviews will be transcribed, coded and results anonymised using pseudonyms. Quotes from interview may be used, but these will also be anonymous – names and identifying features will be removed. Collected data will be destroyed after 10 years in accordance with the recommendations made in the good practice guidelines for research by the Economic Social Research Council.

What will happen if I do not want to carry on with the study?

You can withdraw from the study at any point during interviews or observations without providing reason. You are also entitled to withdraw up to **4 weeks after you have provided data**.

What if I have any questions?

If you have any questions or have a concern about any aspect of the study, you can speak to the principal investigator, Christopher Golding, or to the supervision team, Professor Tyrone Pitsis and Dr Matthew Mount. Their details are at the end of this information sheet.

What will happen to the results of the research study?

The results will primarily form the basis of my doctorate thesis at the Durham University. It is also likely that they will form the basis of academic papers in the future that will be presented at conferences and published in academic journals. A summary report of the findings of the study will also be provided to TechCorp, the partner of this research.

If you are interested in obtaining a copy of the findings and/or a copy of the final published article, you can contact the principal investigator who will be happy to oblige. Your individual results will not be made identifiable in any of these outlets.

Who is organising and funding the research?

This research forms the basis of a PhD project by Christopher Golding through Durham University. The study has been funded by the Economic Social Research Council (ESRC), part of UK Research & Innovation, who provide funding for high quality research into social and economic issues that will have an impact on business, the public sector and civil society.

Who has reviewed the study?

This study has been granted ethical approval by a University Ethics Committee.

Where can I find out further information?

If you have any further questions or require additional information, please do not hesitate to contact myself or another member of the research team using the details below:

Christopher Golding | Lead Investigator| Durham University Business School |07557 414507 | Christopher.c.golding@durham.ac.uk

Professor Tyrone Pitsis | Primary Supervisor | Durham University Business School | Tyrone.s.pitsis@durham.ac.uk

Dr Matthew Mount| Secondary Supervisor |Deakin University, Melbourne | Matt.mount@deakin.com.au

7.3 Appendix 3 – Participant Consent Form

PARTICIPANT CONSENT FORM

Title of Project: *Exploring the pursuit of novel technological opportunities in incumbent organizations*

Name of researcher: Chris Golding

Name of supervisors: Prof. Tyrone Pitsis & Dr. Matthew Mount

	Please initial box
1. I confirm that I have read and understand the information sheet dated 01/11/2019 for the above study.	☐
2. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. I acknowledge and understand the risks associated with the study.	☐
3. I understand that my participation is voluntary and that I am free to withdraw up to 4 weeks after providing data, without giving any reason, and without my medical care or legal rights being affected.	☐
4. I agree to take part in the study.	☐

Name of participant	Date	Signature
_____	_____	_____

_____	_____	_____
Name of person taking consent	Date	Signature

Date after which withdrawal is not possible (4 weeks after data collection)

7.4 Appendix 4 – Summary of Interviews

	Role & Department//Org	Interview Method	Time (Minutes:Seconds)
1	OM 1 R&D	Face-to-face	90:25
2	MM 1 R&D	Face-to-face	55:05
3	OM 2 R&D	Face-to-face	102:35
4	MM 2 R&D	Face-to-face	35:02
5	MM 1 R&D	Face-to-face	74:21
6	MM 3 R&D	Face-to-face	49:44
7	MM 4 R&D	Face-to-face	72:59
8	TM 1 R&D	Face-to-face	55:27
9	OM 3 R&D	Face-to-face	35:16
10	MM 5 R&D	Face-to-face	69:04
11	TM 2 R&D	Face-to-face	61:25
12	TM 1 Elevate Quantum	Skype	62:04
13	Academic 1	Skype	44:50
14	MM 6 R&D	Phone	64:47
15	Marketing Consultant	Face-to-face	42:45
16	OM 4 R&D	Face-to-face	56:31
17	OM 5 R&D	Skype	59:59
18	MM 1 OptiCo	Skype	53:24
19	TM 2 Elevate Quantum	Skype	71:31
20	TM 1 CSU	Skype	38:52
21	TM 3 R&D	Skype	61:41
22	TM 4 R&D	Skype	38:27
23	Researcher 1 Government	Skype	55:43
24	TM 1 Government	Face-to-face	125:00
25	OM 6 R&D	Face-to-face	50:13
26	TM 5 R&D	Face-to-face	59:23
27	OM 4 R&D	Face-to-face	51:59
28	MM 7 R&D	Face-to-face	49:52
29	OM 5 R&D	Face-to-face	67:52
30	OM 7 R&D	Face-to-face	52:59
31	OM 1 Petrol Tech	Skype	30:00
32	MM 2 R&D	Phone	54:56
33	TM 1 Government	Face-to-face	121:03
34	MM 8, R&D	Phone	35:06
35	TM 2 Government	Face-to-face	58:07
36	Security Consultant	Face-to-face	72:10
37	OM 4 R&D	Face-to-face	52:57
38	MM 4 R&D	Face-to-face	48:11
39	TM 6 R&D	Skype	54:30
40	MM 5 R&D	Face-to-face	29:52
41	OM 1 CSU	Phone	25:17
42	Velocity Technology MMs	Skype	54:50

43	OM 1 R&D	Face-to-face	67:04
44	TM 7 R&D	Face-to-face	58:02
45	OM 4 R&D	Face-to-face	62:39
46	Academic 2	Skype	54:30
47	OM 1 CSU	Face-to-face	35:02
48	OM 1 CSU	Face-to-face	40:00
49	OM 4 R&D	Phone	43:02
50	MM 2 R&D	Phone	39:47
51	OM 5 R&D	Face-to-face	68:54
52	MM 5 R&D	Face-to-face	50:39
53	OM 8 R&D	Face-to-face	50:45
54	OM 4 R&D	Face-to-face	46:49
55	OM 1 R&D	Phone	58:26
56	TM 5 R&D	Skype	43:04
57	OM 8 R&D	Phone	23:01
58	OM 8 R&D	Phone	32:13
59	OM 8 R&D	Phone	20:11
60	OM 8 R&D	Phone	40:01
61	MM 4 R&D	Face-to-face	46:00
62	OM 4 R&D	Face-to-face	53:53
63	TM 1 & OM 8 R&D	Face-to-face	84:44
64	OM 9 R&D	Face-to-face	53:36
65	MM 5 R&D	Phone	41:26
66	OM 2 CSU	Phone	52:25
67	OM 8 R&D	Phone	38:17
68	OM 8 R&D	Phone	29:12
69	OM 3 CSU	Skype	52:39
70	OM 8 R&D	Phone	22:18
71	MM 5 R&D	Skype	54:21
72	OM 8 R&D	Phone	32:47
73	OM 8 R&D	Phone	45:19
74	MM 4 R&D	Skype	45:09
75	TM 2 R&D	Phone	52:53
76	MM 5 R&D	Skype	32:50
77	OM 8 R&D	Phone	28:00
78	MM 4 R&D	Skype	52:29
79	MM 2 R&D	Skype	42:17
80	OM 8 R&D	Phone	35:40
81	OM 8 R&D	Phone	38:30
		TOTAL	6,400 Minutes

7.5 Appendix 5 – Summary of Events Observed

	Event/Description	**Duration (Minutes)**
1	Meeting between OptiCo & MMs from TechCorp R&D to discuss roadmap for commercialization of QKD	46
2	Online meeting between TechCorp R&D MMs/OMs and counterparts in other global technology firms regarding commercial prospects of QKD	75
3	Internal meeting between MMs from TechCorp CSUs & R&D to discuss commercial prospects of QKD	62
4	TechCorp R&D weekly team meeting on QKD	42
5	TechCorp R&D weekly team meeting on QKD	45
6	TechCorp R&D weekly team meeting on QKD	40
7	TechCorp R&D weekly team meeting on QKD	44
8	TechCorp R&D "team away day" for members working on QKD project	427
9	Techno-economic analysis meeting between members of TechCorp R&D	33
10	"Deep dive" workshop/meeting between TechCorp R&D MMs, OptiCo MMs and customer to discuss the potential usage of QKD and to identify viable use cases in preparation for trials	243
11	TechCorp R&D weekly team meeting on QKD	30
12	TechCorp R&D weekly team meeting on QKD	32
13	TechCorp R&D weekly team meeting on QKD	44
14	TechCorp R&D weekly team meeting on QKD	31
15	Industrial event hosted by TechCorp R&D to celebrate launch of commercial QKD product. Dignitaries from collaborators involved in work, as well as government, academia and media outlets	311
16	TechCorp R&D weekly team meeting on QKD	26
17	TechCorp R&D weekly team meeting on QKD	22
18	TechCorp R&D weekly team meeting on QKD	30
19	TechCorp R&D weekly team meeting on QKD	29
20	TechCorp R&D weekly team meeting on QKD	31
21	Government-funded collaborative project quarterly review meeting. Involved TechCorp and other industrial partners responsible for completing various aspects of workflow	175
22	TechCorp R&D weekly team meeting on QKD	35
23	TechCorp R&D weekly team meeting on QKD	23
24	Meeting between TechCorp R&D MMs and TMs/MMs from Delta Technologies to discuss research progress and potential collaboration	200
25	TechCorp R&D weekly team meeting on QKD	28
26	TechCorp R&D weekly team meeting on QKD	26
27	TechCorp R&D weekly team meeting on QKD	15
28	TechCorp R&D weekly team meeting on QKD	15
29	TechCorp R&D weekly team meeting on QKD	27
30	TechCorp R&D weekly team meeting on QKD	25
31	"Deep dive" workshop between TechCorp, OptiCo and Energy Tech	110

32	Meeting between OMs in TechCorp CSUs and R&D to discuss technical requirements of commercial QKD product	46
33	TechCorp R&D weekly team meeting on QKD	21
34	TechCorp R&D weekly team meeting on QKD	24
35	TechCorp R&D weekly team meeting on QKD	25
36	Second “deep dive” workshop between TechCorp, OptiCo and Energy Tech as part of government-funded collaborative project	59
37	Internal meeting between TechCorp R&D OMs and OMs in the CSUs to discuss developing relationship with Energy Tech and possibility of trials with similar cusotmers	30
38	Third “deep dive” workshop between TechCorp, OptiCo and Energy Tech as part of government-funded collaborative project	59
39	TechCorp R&D weekly team meeting on QKD	26
40	TechCorp R&D weekly team meeting on QKD	25
41	TechCorp R&D weekly team meeting on QKD	26
42	Fourth “deep dive” workshop between TechCorp, OptiCo and Energy Tech as part of government-funded collaborative project. Elevate Technologies also in attendance.	61
43	TechCorp R&D weekly team meeting on QKD	29
44	TechCorp R&D weekly team meeting on QKD	30
45	TechCorp R&D weekly team meeting on QKD	30
46	Meeting between TechCorp R&D and CSUs to discuss QKD venture propositions from OptiCo and Red Technologies	312
47	TechCorp R&D weekly team meeting on QKD	23
48	TechCorp R&D weekly team meeting on QKD	25
49	TechCorp R&D weekly team meeting on QKD	27
50	TechCorp R&D weekly team meeting on QKD	26
51	TechCorp R&D weekly team meeting on QKD	32
52	TechCorp R&D weekly team meeting on QKD	32
53	TechCorp R&D weekly team meeting on QKD	30
54	TechCorp R&D weekly team meeting on QKD	29
55	TechCorp R&D weekly team meeting on QKD	30
56	TechCorp R&D weekly team meeting on QKD	30
57	TechCorp R&D weekly team meeting on QKD	28
58	TechCorp R&D weekly team meeting on QKD	28
59	TechCorp R&D weekly team meeting on QKD	29
60	TechCorp R&D weekly team meeting on QKD	29
61	TechCorp R&D weekly team meeting on QKD	27
62	TechCorp R&D weekly team meeting on QKD	25
63	TechCorp R&D weekly team meeting on QKD	32
64	TechCorp R&D weekly team meeting on QKD	27
65	TechCorp R&D weekly team meeting on QKD	28
66	TechCorp R&D weekly team meeting on QKD	29
67	TechCorp R&D weekly team meeting on QKD	29
68	TechCorp R&D weekly team meeting on QKD	30
69	TechCorp R&D weekly team meeting on QKD	29

70	TechCorp R&D weekly team meeting on QKD	28
71	TechCorp R&D weekly team meeting on QKD	26
72	TechCorp R&D weekly team meeting on QKD	24
	TOTAL	3857

7.6 Appendix 6 – Summary of archival documents collected

Source	Number/Amount	Use in Analysis
Public (Collected via Google and Lexis Nexis)		
TechCorp Notice of AGM 2017	20 pages	• Contextual background on TechCorp as an organization. Understand their history and vision, as well as strategic aims (past, present and future). In particular, how the organization had been performing over time. Useful information on the nature of the R&D department and CSUs and how this changed over time. • Understand the nature of governance and strategy at TechCorp. Insight into the financial dynamics of the organization, and how/where they were investing in the organization. • Comprehend what critical strategic initiatives were, particularly from perspective of CSUs, and what key decision-makers at the organization saw as important – or proclaimed to be important – in the short, medium and long-term. • See where QKD sat in terms of TechCorp's broader portfolio of offerings.
TechCorp Notice of AGM 2018	19 slides	
TechCorp Notice of AGM 2019	19 slides	
TechCorp Voting Results 2017	2 pages	
TechCorp Voting Results 2018	3 slides	
TechCorp Voting Results 2019	2 pages	
TechCorp AGM Presentation Slides 2017	23 slides	
TechCorp AGM Presentation Slides 2018	20 slides	
TechCorp AGM Presentation Slides 2019	19 slides	
TechCorp Annual Report 2012	115 pages	
TechCorp Annual Report 2013	115 pages	
TechCorp Annual Report 2014	120 pages	
TechCorp Annual Report 2015	143 pages	
TechCorp Annual Report 2016	152 pages	
TechCorp Annual Report 2017	242 pages	
TechCorp Annual Report 2018	220 pages	
TechCorp Annual Report 2019	190 pages	
TechCorp Annual Report 2020	209 pages	
TechCorp Strategic Report 2015	74 pages	
TechCorp Strategic Report 2016	87 pages	
TechCorp Strategic Report 2020	63 pages	
TechCorp webpages on cybersecurity research and innovation (06/2020)	2 pages	• Understand what TechCorp's outlook on cybersecurity was, in terms of what were the critical issues they perceived, and what they were marketing their key technologies and solutions to be. • Appreciate how QKD fitted into this business segment/portfolio.
Government report on cybersecurity	60 pages	
Government report on quantum computing	48 pages	

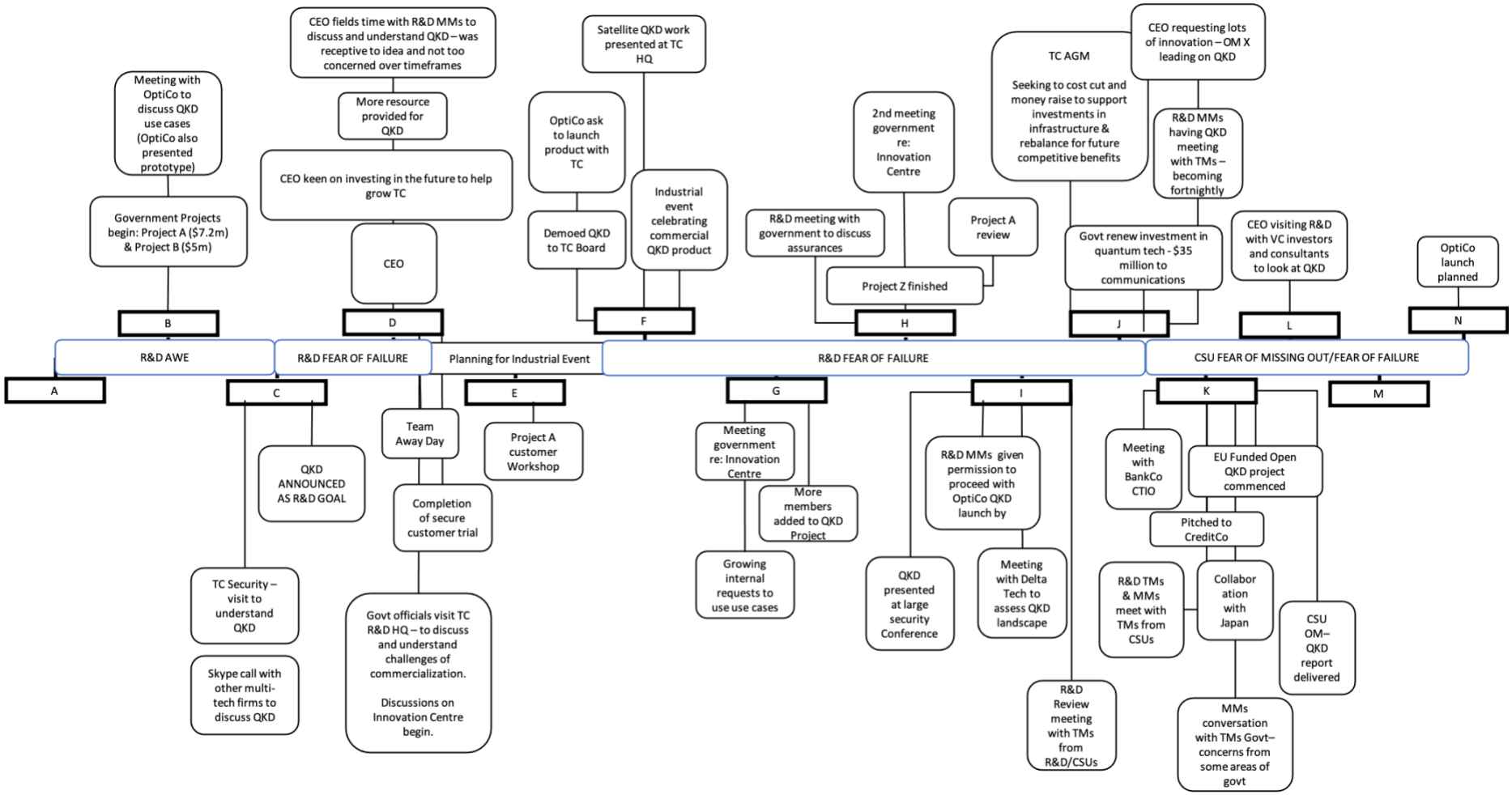
Government quantum technology programme Annual Report 2018	60 pages	• Understand how QKD was perceived and portrayed by the government, in terms of what its purpose and/or value was or would become. • Provide background on government investment into QKD, and contextualize this spending in comparison to other quantum technologies. • Offer insight into the role that TechCorp were said to play within the QKD domain – or were expected to play – as well as what their role was said to be, more broadly in the eyes of government. • Appreciate who were the other 'key players' in the quantum ecosystem, in particular who might be perceived as potential competitors.
Government quantum technology roadmap 2018	30 pages	
Government committee report on quantum technology 2017-19	73 pages	
Government short paper on quantum technology	5 pages	
Quantum technologies: Blackett Review	64 pages	
Government Industrial Strategy (2019)	256 pages	
Government National strategy for quantum technologies (2016)	12 pages	
Government news story: Commercialising quantum technology	1 page	
Government: Quantum technology patent overview	48 pages	
Government advice to businesses on QKD	4 pages	
EU Commission on quantum technology and implications for policy	34 pages	• As above: understand how QKD was perceived from a European perspective. Particularly, how the EU were funding/investing into QKD, and what their ambitions were for the technology.
Quantum technology roadmap: European community view	25 pages	
Academic paper on 5G & QKD	9 pages	• Develop background understanding of QKD as a technology. Understand what the purpose of QKD was in communications systems, as well as what the main challenges to the use of the technology was. In particular, appreciate what alternative solutions existed, and could potentially be used. • Understand what the latest (reported) developments were in the field of QKD, quantum computing and quantum-secure communications. • Develop understanding about the nature of the QKD ecosystem, in terms of who were the major potential providers, and who had roles to play in developing/supplying the technology.
Royal Holloway Series 2011: QKD – Awesome or Pointless?	13 pages	
Marketing report on quantum enabling photon sources 2018-2022	45 pages	
Assorted news and media articles from Lexis Nexis	161 articles (80 collected up to 01/2019 in early stages of research; 81 additional articles identified throughout rest of research process)	

		• See what the past, present and future perspectives on QKD were, outside of TechCorp, especially how the market for QKD would develop. • Understand, historically, what role TechCorp had played in the research and development of QKD.
Private (provided by informants)		
TechCorp R&D Governance document	1 slide	• Understand what processes and narratives TechCorp had in place about innovating at the organization. • Appreciate the different roles played by different parts of the business, and how these were measured and/or judged.
TechCorp Innovation Process	2 pages	
TechCorp Innovation Continuum	10 pages	
TechCorp R&D Scorecard	1 slide	
TechCorp CSU Scorecard	2 slides	
TechCorp Security report on commercial prospects of QKD	24 slides	• Understand how R&D perceived and were trying to portray QKD as a product to TMs in both the R&D department and CSUs.
TechCorp R&D white paper on quantum research	4 pages	• Understand how R&D perceived and were trying to portray quantum research, especially QKD, to key organizational decision-makers in the R&D department. • Insight into the consequences that managers perceived from quantum research being successful (or not), and what future scenarios they imagined and were preparing for.
TechCorp R&D report: Consequences of breaking RSA	22 pages	• Understand how QKD was being presented to managers in the CSUs, as well as to see what alternative solutions (if any) were being suggested or explored as well (i.e what solutions QKD might be competing with)
TechCorp customer requirements flowchart	1 page (A1) + 4 pages (A4)	• Appreciate what R&D managers were doing, or perceived needing to be done, to commercialize QKD. • See how R&D managers intended to articulate QKD to employees not involved in the
TechCorp evidence on QKD for Govt. scientific committee and establishment of a quantum technology innovation centre	2 pages	
TechCorp quantum newsletter	4 pages	
TechCorp quantum newsletter plan	2 pages	

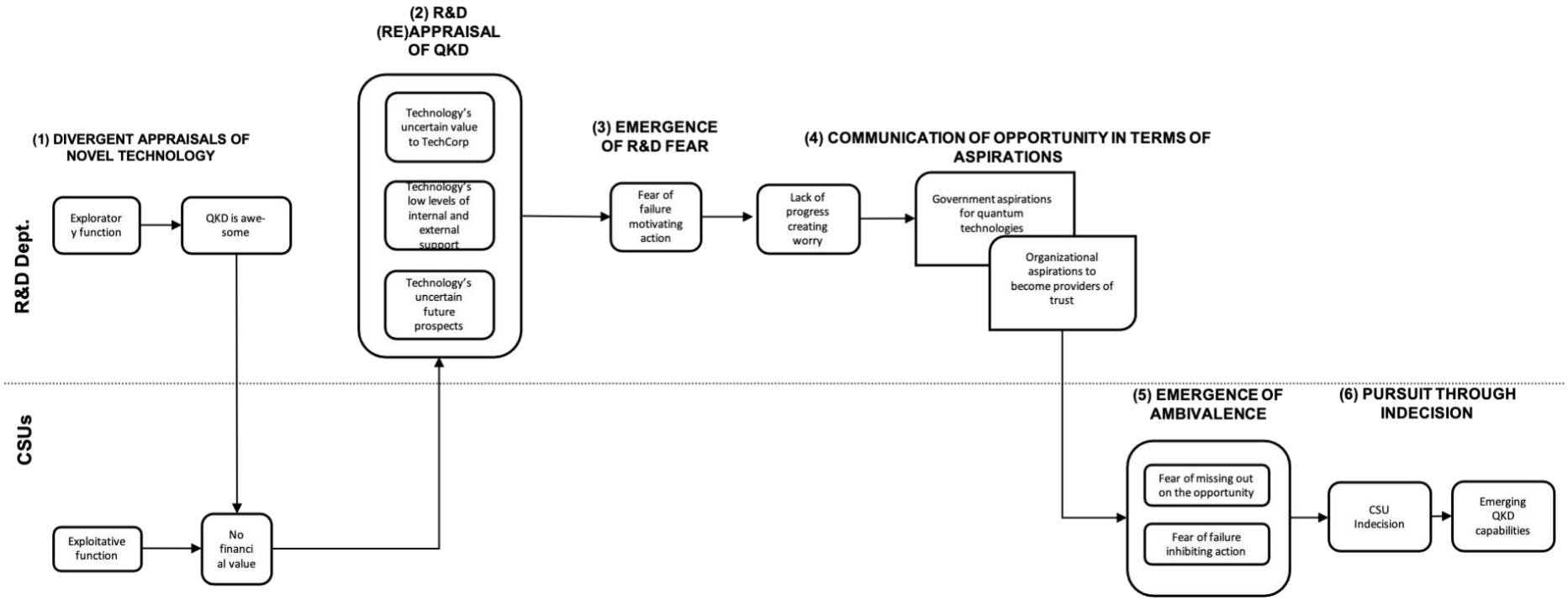
TechCorp techno-economic analysis	31 pages	commercialization efforts in R&D and the CSUs, as a means of generating understanding and support for the technology.
TechCorp R&D summary of Quantum Tech Conference	13 slides	• Understand what R&D managers had identified as critical and relevant issues to their ongoing efforts at commercializing QKD.
TechCorp use cases for QKD report	21 pages	• Understand how TechCorp R&D managers perceived the commercial prospects of QKD. • See what data R&D managers had collected and intended to use as evidence to support claims for the commercialization of QKD. • Understand how they understood and construed the potential use of QKD in the real-world by actual customers.
Delta Technologies: Quantum-safe security	39 slides	• Understand the dynamics (or proposed dynamics) between TechCorp and Delta, a technology provider who wished to work with TechCorp. • See how Delta interpreted the future of QKD, and how that aligned to that of TechCorp R&D managers. • Understand how other organizations outside of TechCorp were trying to articulate and sell QKD technology.
Project A: Techno-economic analyses	63 pages	• Contextualize the broader perceptions on/of QKD by others in the industry, particularly around the potential/likely economics of QKD, and what use cases that others had envisaged. • See what activities had been carried out/were to be carried out in the future, to support commercialization of QKD. Especially around component development (i.e. who were or would be key suppliers) and likely customers.
Project A: Use case report	20 pages	
Project A: Work Schedule	12 pages	
Project A: TechCorp & MiningCo minutes	4 pages	
Project A Q3 Meeting notes	6 pages	
Project A: TechCorp & Military meeting agenda	2 pages	
Project S: Use case summary	31 pages	
Project S: Use cases	81 pages	

		• Triangulating evidence to be used alongside observations made of various meetings between TechCorp and customers/commercial partners.
Emails	Approx. 150 emails (consented to use)	• Insight into internal dynamics between different groups at TechCorp involved in attempted commercialization of QKD. Understand roles and responsibilities. • Appreciate how R&D, in particular, were operating to try and bring about the commercialization of QKD. • Contextual background/evidence for discussions in certain team meetings.
		Total = 3,359 pages/slides

7.7 Appendix 7 – Example Visual Map



7.8 Appendix 8 – Example of box & arrows diagrams used in Stage 5 of analysis



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