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Challenging the Exploration and Exploitation Dichotomy: Towards Theory Building in Innovation Management

By

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Submitted in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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October 2019

Abstract

The conceptual dichotomy between exploration and exploitation, importantly highlighted in March's (1991) seminal paper, has been widely employed to study innovation management processes and resource allocation decisions in organisations. Despite its extensive usage, the validity of this dichotomy has not been subjected to adequate theoretical scrutiny and empirical support. Therefore, this thesis provides a critical examination of the origins and consequences of exploration and exploitation, and questions this dichotomy especially as pertaining to its application in innovation management. It challenges the taken-for-granted assumption that these two concepts refer to distinct and observable decision-making processes and concludes that this is an assumption largely unwarranted. A systematic literature review about the use of this dichotomy was conducted in the context of innovation management and the findings confirmed that although studies have proposed related notions, such as ambidexterity, as a way to overcome the supposed trade-off between exploration and exploitation. It is confirmed that there has been no attempt hitherto to question the validity of this dichotomy. Also, little empirical evidence was found to suggest that the understanding of managing innovation can be enhanced through a reliance on this dichotomy. Thus, it is argued that the employment of this dichotomy in practices for managing innovation has not been justified and should be investigated directly through empirical evidence.

To investigate exploration and exploitation both as performance criteria and internal processes, a mixed-method design that utilises data envelopment analysis (DEA) as quantitative method, and a focus group supplemented by interviews as the qualitative method was relied on. Findings from DEA indicated that exploration and exploitation can be used as criteria for performance evaluation in innovation. However, findings from the qualitative part of the study suggested that in practices for innovation management, exploration and exploitation are not viewed as separated internal processes; hence, this distinction is not featured in decision-making during innovation processes. This means that the classification based on exploration and exploitation is not used for appraisal of activities or projects in managing innovation. It is therefore concluded that the dichotomy of exploration and exploitation is not valid in practices for innovation management and thus its application in theorising innovation should be reconsidered; thus, studies of innovation management should not unquestioningly rely on this dichotomy, because it does not reflect organisational reality. Consequently, this study contributed to innovation management literature by pointing to alternative possible directions, such as 'problem-solving', in theorising the processes of innovation management for future studies.

Table of Contents

List of Tables

List of Figures

Acknowledgement

As I am writing this acknowledgement, memories just vividly appear in the mind. It has never been an easy journey doing a PhD, but the challenges are what make it just worthwhile. Approaching the end of the study, my heart is filled with gratefulness because it would be impossible to reach where I am without all the help and support I have received. Hence, I would want to take this opportunity to express my appreciation to everyone who has been by my side in this journey.

First, I would like to send my sincere gratitude to my principle supervisor Dr. ir. Rob Dekkers. I would like to thank Rob for believing in me even when I first walked into his office, I have no idea of what an interesting research project mean. His help and support not only enable the completion of the thesis, but also allow me to become a better version of myself. Thanks need also be express to Professor Robert Chia, my second supervisor. It is Robert who always provide a fresh perspective on matters and emphasis on the art of writing that helps me continually improving.

Second, I want to extend my heartfelt thanks to my parents and families back home. Nothing would be possible without the robust support provided through the years, allowing me to focus on the work and nothing else.

Third, I wish to thank my colleagues in University of Glasgow, past and present PhD students, for always being supportive and inspiring. Special thanks to Dr. Yameng Zhang, Dr. Kaidong Yu, Dr. Nita Ali, and Dr. Honglan Yu for showing me what a completed PhD would mean. Also, thanks Ms Marianna Koukou, Mr Mohammed Aldossary and Mr Aiden Gilani, your company has made Glasgow feels like home. Thanks also all the friends who name is not mentioned, life would be different without all of you.

Last but not least, I would like to thank my Sun who is an expert of bursting into my life, saving all my rainy days. Approaching the end, it is her love that motivates and encourages me not to give up, and to believe a bright future upon my completion. And here we are, I can see happiness awaits in the next chapter.

Qijun Zhou

20/10/2019, Glasgow

Author's Declaration

"I declare that, except where explicit reference is made to the contribution of others, that this dissertation is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution."

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Chapter 1 Introduction: Exploration Verses Exploitation and Innovation Management

1.1 Introduction

This thesis questions the theoretical notion of exploration and exploitation that is commonly used for theorising in the context of innovation management. It challenges the dichotomy between exploration and exploitation and examines its validity. This chapter starts with introducing the background of this study and the context of innovation management in Section 1.2. This is followed by showing how current debates in exploration and exploitation have influenced the direction of this study focusing on innovation management in Section 1.3. This chapter ends with a discussion of how arguments were constructed in this study in Section 1.4 and a presentation of the structure of the thesis in Section 1.5.

1.2 Research Background and Contextualisation

In academic research specific to managing innovation in organisations, it appears that studies often rely on different theoretical constructs drawn and adopting from different theoretical constructs in other disciplines; as a result, it is often difficult to translate some of the findings from these studies into managerial practices (Tidd, 2001, p. 173). Thus, it has been argued that managing innovation should not simply be about applying concepts from other management disciplines to innovation management (Tidd and Bessant, 2018, p. 2). However, some studies still tend to do so.

One of the well-refereed concepts that has been drawn on to informing the field of innovation management is the dichotomy made by Mach (1991) regarding exploration and exploitation. In the seminal paper entitled 'Exploration and Exploitation in Organisational learning', March (1991, p. 71) argues that when viewing organisations as systems, the central concern of these systems lies in "*exploration of new possibilities*" and "*exploitation of old certainties*". For him, it is the tendency to increase exploitation and reduce exploration that may eventually lead to the self-destruction of organisations. According to March (ibid., p. 71), the difficulty in avoiding this destruction is that exploration and exploitation are distinct activities that not only require different forms and structures from organisations, but also compete for resources available. Hence, March (ibid., p. 73) further argues that it is essential for organisations to maintain a delicate balance between exploration and exploitation when considering resource allocation. This dichotomy between exploration and exploitation has been used and popularised in much of the innovation management literature.

One key reason for the popularity of this notion may lie the fact that it provides a possible explanation for academic studies in the domain of innovation management regarding 'what to change'. From an academic point of view, it is often difficult for organisations to frame appropriate agenda in pursuing radical or incremental developments that is involved in innovation processes (Bessant, 2003, p. 762). Here, radical development means searching for totally new options for organisations, whereas incremental developments are defined as developments based on what is already there (ibid.). According to Dewar and Dutton (1986, p. 1423), central to the distinction of radical and incremental development is whether managers are familiar with the knowledge involved in that development. In this context, the dichotomy of exploration and exploitation become relevant to the challenge because radical development implies a preference for exploration of new possibilities, and incremental development implies the exploitation of old certainties. This is the reason why perspectives based on the dichotomy has also been applied in the discipline of innovation management. For example, Hernandez-Espallardo et al. (2011, p. 206) used the exploration and exploitation to define different types of innovation; and Zacher et al. (2016, p. 38) studied how exploration and exploitation has a joint effect on innovation. As a result, managing exploration and exploitation has been considered by academic studies as one of the key factors in managing innovation.

These understandings pointed to an unresolved problem that underpins the investigation of this study regarding whether the application of this dichotomy in the context of innovation management is valid and what exactly does it mean related to practices of managing innovation. To be more specific, first, it seems that in its original proposition, the concepts of exploration and exploitation were developed theoretically without any empirical support in the work of March (1991). If the proceeding studies simply employed this distinction between exploration and exploitation without providing any additional empirical support to sustain it, then this dichotomy should be empirically investigated more rigorously. Second, because exploration and exploitation originate in the discipline of organisational learning, it is still debateable whether they are actually helpful in the context of innovation management. If using this dichotomy in innovation management as a theoretical construct is not thoroughly examined and justified, then it is necessary to question if, at all this dichotomy can contribute to a better understanding of innovation processes and, by its implication, how to manage these processes. Third, it is not clear whether in practice, implementing this dichotomy will lead to advancing our understanding of innovation, and thus, will help organisations to be more successful in innovation. This study, therefore aims at thoroughly investigating exploration and exploitation, focusing on the logical reasoning behind this

notional dichotomy and the usefulness of this distinction; by doing so, contributions are expected to be made to scholarly knowledge in building a better theoretical understanding for innovation management.

1.3 Positioning the Study

With some background of this study discussed, this section will introduce how this study see itself fits in the current studies on exploration and exploitation in innovation management and why this study is important. To this purpose, without looking into details on every relevant paper in the topic, the first subsection will briefly discuss how studies have developed exploration and exploitation based on March (1991) and to see whether alternative arguments exist based on some previous literature reviews. The second subsection will then discuss how this doctoral study is positioned in this topic by looking at the validity of the proposition of exploration and exploitation.

1.3.1 Current Debates in Exploration and Exploitation

As mentioned in Section 1.2, the use of the notion of exploration and exploitation has attracted attention from research, and yet, the outcomes from current studies are rather inconsistent in terms of (1) what do they mean, (2) how to manage them, and (3) the consequences for performance when managing them (Almahendra and Ambos, 2015, p. 1; Gupta et al., 2006, p. 693; Lavie et al., 2010, p. 110; Li et al., 2008, p. 107; Raisch et al., 2009, p. 685). To be more specific, first, studies have tended to define exploration and exploitation differently. For example, Li et al. (2008) pointed out that there is ambiguity in how exploration and exploitation is defined and used in innovation management. They further suggested that this may be due to the different levels of the analysis for different functions (e.g. searching for scientific, product or market knowledge). Hence, to validate this notion in innovation management, it is necessary to make clear how exploration and exploitation have been defined in innovation management (this will be presented in Section 3.3). Second, searching for methods of managing exploration and exploitation, previous studies have put forward perspectives that reflect different interpretations to the notion of exploration and exploitation (Lavie, 2010, p. 129). It is important to start with these existing interpretations and to see whether further justification of exploration and exploitation can be found, especially in innovation management (details on these perspectives can be found in Section 3.4). Last, studies have reported conflicting outcomes in terms of the performance implication for managing exploration and exploitation, with both positive and negative

impact being reported (ibid., p. 138). Therefore, further examinations regarding the evidence sustaining the dichotomy of exploration and exploitation are needed. This also contributes to the searching of explanations to the results in existing studies. Overall, these current debates about exploration and exploitation have reinforced the necessity for further investigation into the notion, with a focus on validating the construction and implementation of exploration and exploitation, with substantial evidence.

1.3.2 Framing the Research Scope

Based on the above discussion, the current debates surrounding exploration and exploitation has led to challenges for future studies. Table 1.1 presents an overview of these challenges stated in Lavie et al. (2010, p. 142), which can provide some guidance of how this study may position itself.

Table 1.1 Current Challenges in Exploration and Exploitation Studies

Challenges	Description
Scope of phenomenon	Should exploration–exploitation be narrowly defined in the knowledge domain or broadly in various domains?
Discerning exploitation from exploration	Should existing knowledge development be considered an act of exploration or exploitation?
Conceptualization	Should exploration and exploitation be viewed as opposing ends of a continuum or as discrete choices?
The nature of association	Are exploration and exploitation complementary or contradictory endeavours?
Performance implications	Do organizations benefit from balancing exploration and exploitation or from specialization in either activity?
Antecedents	Why do some organizations pursue exploration while others opt for exploitation?
The notion of balance	Should organizations seek equal proportions of exploration and exploitation or some other optimal mix?
Assumptions	Can we reconcile normative assumptions about desirable balance and behavioural tendencies to specialize?
Conceptual clarity	What is the difference between balance and ambidexterity?
Modes of balancing	What is the best mode for balancing exploration and exploitation?
Intentionality	How important is intentionality for managing the balance between exploration and exploitation?

Source: Lavie et al. (2010, p. 142)

Examining these challenges in more detail, this study argues that the premise of dealing with most challenges listed is to validate and make clear of the formulation of exploration and exploitation itself. In other words, if the construction of the dichotomy is not validated in terms of theoretical construction and empirical evidence, then it is possible that exploration and exploitation should not be considered as separate for research into innovation

management. Hence, this thesis examines whether the notion of exploration and exploitation is valid both theoretically and empirically in existing studies through an in-depth review of the literature. For exploration and exploitation to be validated theoretically, existing studies around the notion should include aspects of 'falsifiability' and 'utility' according to Bacharach (1989, p. 501), whereas empirically, direct evidence from practice is needed. Without this validation, it is not very helpful to dive directly into how to manage or balance exploration and exploitation or what the actual consequence to organisational performance adopting different methods are, based on this notion. If exploration and exploitation is not validated in existing literature, this study will aim to provide evidence examining this dichotomy through empirical data and analysis. Consequently, the importance of this study lies in building a foundation for theorising in innovation management through examination of exploration and exploitation.

1.4 The Process of Constructing Argument

The previous sections have made clear the main purpose of conducting this study. Based on research objectives, this section will introduce how the overall argument will be constructed and how this investigation into exploration and exploitation in innovation management will unfold. The first subsection will formulate the research aim of this study, followed by research objectives. The research aim, objectives and questions will be revisited in Chapter 4 after the in-depth review of literature. This will lead to the discussion of searching for appropriate method accordingly to this aim. With key steps of the logic flow of the whole thesis discussed, the last subsection will specify on the intended contribution to scholarly knowledge of this study.

1.4.1 Research Objectives

Based on the background discussed, the aim of this study is set to validate the notion of exploration and exploitation in the context of innovation management to provide insights into how innovation may be better understood and managed. By 'validation' this study means to take a step back and examine whether exploration and exploitation should be studied as separated constructs in innovation management. Accordingly, this doctoral study has set the following research objectives:

- To conduct a comprehensive overview of the literature on exploration and exploitation in innovation management.

- To understand and evaluate the theoretical basis and logical reasoning of the distinction of exploration and exploitation, specifically as employed in innovation management.
- To provide empirical evidence demonstrating how exploration and exploitation is reflected in innovation management practice.

1.4.2 Searching for Suitable Methods

Considering that it may be the first attempt to validate and question the construction of the distinction between exploration and exploitation, the outcomes from this study should be supported adequately by theoretical and empirical aspects. For theoretical considerations, a literature review with 'systematic approaches' can be regarded as a starting point to achieve the first research objective of having a comprehensive overview on the notion in innovation management; this review can be found in Chapter 3. Additionally, research frameworks developed based on previous theoretical models is also included for the purpose of theoretical validity in this study; this will be presented in Chapter 4. In terms of empirical evidence, multiple methods of data collection and analysis may be needed because exploration and exploitation are interpreted differently according to different levels of analysis; further justification will be demonstrated in Chapter 5. The next subsection will indicate how the key steps in this study and how they are presented in this thesis.

1.4.3 Logic of this Study

Generally, the logic flow used can be described into the following steps. Note here that these steps are just reporting what has been done throughout this study. These are: 1) what has been done about the topic, 2) what may be the problem, 3) how may the problem be identified, 4) Has this problem being addressed in the selected research context, 5) how to articulate the problem, 6) how can this problem be attempted to solve 7) what are the outcomes of this attempt. Before presenting the flow and structure, it is also important to ensure and keep track that all the necessary discussions are include in the thesis, hence, Table 1.2 provides an overview of these discussions and their location in the thesis chapters. This logic flow has then led to the intended contribution to knowledge of this doctoral study, which will be discussed in the next subsection.

Table 1.2 Breaking down the Thesis According to the Logic Flow

Logic Flow	Corresponding discussion in the thesis
Introducing the topic	Background of exploration and exploitation is discussed. Initial research aims and objectives presented (Chapter 1)
Understand what has been done in the topic	A brief review on the notion of exploration and exploitation (Section 2.2), review of studies in different management disciplines (Appendix I)
How may research problem be identified?	Some useful viewpoints for finding research agenda discussed (Section 2.4)
Has this problem being addressed in the selected research context?	A systematic review focused specifically on exploration and exploitation in innovation management (Chapter 3)
How to articulate the problem?	Problem statement discussed, and two arguments proposed (Chapter 4). Refined research aim, objectives and questions presented based on the outcomes of literature review.
How can this problem be attempted?	Two research frameworks developed (Section 4.4), design a suitable research (Chapter 5), detail designs on empirical inquiry (Sections 6.2 and 6.3; Sections 7.3 and 7.6)
What are the outcomes of this attempt?	Findings from different methods used (Chapter 6 and Chapter 7), amalgamating findings (Chapter 8)
Drawing conclusion	Concluding remarks (Chapter 9)

1.4.4 Contribution of this Study

Based on its research aim, this study contributes to scholarly knowledge through testing the theoretical notions of exploration and exploitation, and thus, building new theoretical perspectives in managing innovation. Departing from the dominant use of exploration and exploitation as distinct and separated constructs in innovation management, it questions the validity of this dichotomy and provides direct evidence to show the inherent ambiguity in its application. It maintains that making clear the distinction between exploration and exploitation may enable the formulation of alternative models that explain more phenomena in practices for innovation management. Specifically, if the distinction between exploration and exploitation is validated, future research focus may stay on finding suitable methods to manage this distinction that lead to better innovation outcomes. However, if this distinction is contradicted, new perspectives that taking exploration and exploitation as inseparable should be considered and theoretical frameworks based on this finding can be developed. Ultimately, this answers the question of 'what to change' discussed in Section 1.2 and form a link between academic understanding and managerial practices for innovation management.

1.5 Structure of Thesis

With Table 1.2 in Subsection 1.4.3 demonstrating the key steps in this study, this section will be focused on the overall structure of the thesis, as shown in Figure 1.1.

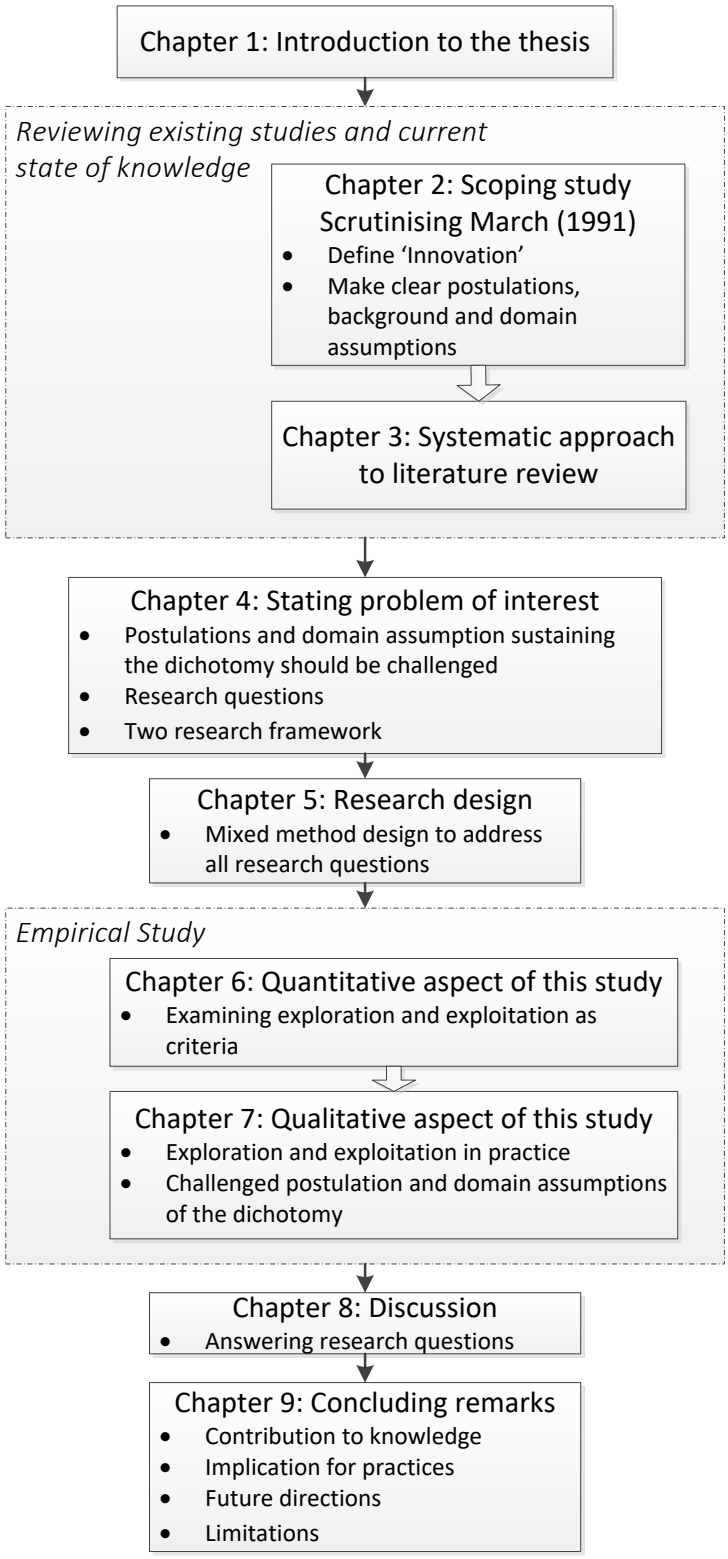


Figure 1.1 Structure of Thesis

Chapter 2 Scoping Study: Positioning the Research in Exploration and Exploitation

2.1 Introduction

The aim of this chapter is to shed light on some fundamental aspects in this study. This includes: (1) the notion of exploration and exploitation, (2) the context of innovation management, and (3) further specifics on how exploration and exploitation are studied in innovation management building on Chapter 1. By achieving these aims, this chapter acts as a scoping study for the whole thesis. To start with, Section 2.2 will give a full description of the dichotomy of exploration and exploitation building on the classic work of March (1991). Next, Section 2.3 presents a justification on the research context of innovation management in this study. This chapter ends with Section 2.4 with three useful viewpoints for articulating the research agenda of this study.

2.2 Exploration and Exploitation: The Dichotomy

The first task of this chapter is to understand what exploration and exploitation are. Hence, this section will provide an in-depth scrutiny of exploration and exploitation in the context of management studies based on the seminal paper by March (1991). It is also worthwhile to track what development has taken place in the later work of James March regarding the notion. To this purpose, the first subsections will present in detail what has been discussed in March's (ibid.) paper and delve deeper into his theoretical constructions. The next subsection explores some development of exploration and exploitation made by March himself in his later work: Levinthal and March (1993) and March (2006), together with some other studies in organisational learning. The last subsection presents alternative arguments beyond March's (1991) original contribution.

2.2.1 The Seminal Paper: March (1991)

Since March's (1991) seminal paper "*Exploration and Exploitation in Organisational learning*" published in the journal of 'Organisation Science', the conceptual distinction between exploration and exploitation has been the attention of significant of management scholars. By the time this thesis is written, Google Scholar shows this paper has been cited more than 22,000 times. Pursuant to this vastly influential conceptual separation by March (ibid., p. 71), exploration is defined by terms such as *"search, variation, risk taking, experimentation, play, flexibility, discovery and innovation"*, whereas exploitation is described by terms such as *"refinement, choice, production, efficiency, selection, implementation and execution"*. Moreover, March (ibid.) has postulated that both concepts are essential to the survival of organisations but will inevitably compete for the resources

available to them. Despite the widespread acceptance of this dichotomy, Almahendra and Ambos' (2015, p. 4) review suggests that current studies on this topic have failed to provide a conclusive picture. More specifically, they argue that ambiguity still exist in terms of the definition, and conceptualisation of exploration and exploitation; thus, further clarifications are needed (ibid., p. 25). Hence, it is necessary to investigate these concepts in-depth based on the original paper by March (1991), to see whether this proposed dichotomy is logical and supported sufficiently by empirical evidence.

Based on adaptive processes, which are not specified in the paper, March (1991, p. 71) pointed out that organisations make both implicit and explicit choices between exploration and exploitation. These choices are due to (1) distinctive returns that these activities bring, and (2) processes for allocating resources that these activities require. To further justify his conceptualisation of the dichotomy, March (ibid., p. 72) referred to four different strands of study: (1) rational models of choice, (2) theories of limited rationality, (3) approaches to generic organisational learning, and (4) evolutionary models of organisations. Table 2.1 presents how March (ibid.) has used these strands of study in his paper to support his argument on the choice between exploration and exploitation. By linking exploration and exploitation to these theories, March (ibid.) demonstrated that a trade-off was necessary because of the inevitable tension between these two activities.

Table 2.1 Choice between Exploration and Exploitation in March (1991)

Theories	Exploration and exploitation
Rational model of choice	· Assuming there are alternative investment opportunities and each characterised by a probability distribution over returns that is unknown ➢ **Exploration:** gaining new information about alternatives (allocating investment to address uncertainties) ➢ **Exploitation:** using information currently available (concentrating the investment on best alternatives)
Limited rationality	· **Exploration:** search is stimulated if the most preferred known alternative is below the target · **Exploitation:** search is inhibited if the preferred alternative is above the target
Organisational learning	· **Exploration:** invention of new technology · **Exploitation:** refinement of existing technology
Evolutionary models of organisational forms and technologies	· Twin processes in evolution ➢ **Exploration:** Variation ➢ **Exploitation:** Selection

Source: March (1991, p. 72)

To justify the trade-off between the concepts, March reported two theoretical models for describing the role of exploration and exploitation in organisational adaptation. The first model considers mutual learning, presenting the relationship between individual learning and the level of organisational knowledge in both closed and open systems (ibid., p. 74). The proposition is that slow learning, which means that individuals adapt to the knowledge code of the organisation slowly, will allow greater space for learning new knowledge, thus, contributing to exploration (ibid., pp. 75-77). Here, knowledge code means the body of knowledge that an organisation has. This is because slow learner will take more time to adapt to this body of knowledge, and external knowledge will be introduced through the process. Therefore, the overall body of knowledge can be improved. The tension between exploration and exploitation in the first model lies in the conflict between short-term and long-term considerations of the target, outcomes and gains of individual and collective (i.e. organisational) learning.

The second model, regarding the relationship between knowledge and ecologies of competition, demonstrates the process of achieving competitive advantage or surviving competitive processes (ibid., pp. 81-85). The distinction is rooted in the strategic choices between increasing either efficiency (for example, by achieving large-scale manufacturing, i.e. exploitation) or effectiveness (for instance, through creating products that have distinctive features, i.e. exploration) for gaining competitive advantage. Additionally, these choices will depend on the aim of the organisation based on either becoming first or avoiding being the last in the competition; in this context, March (ibid., p. 83) proposed that an organisation's focus on increasing productivity has a positive impact on achieving competitive advantages in competition, but a negative impact on avoiding competitive disadvantages. By presenting his models, March (ibid., p. 85) has advocated the need for trade-offs between exploration and exploitation, and further pointed out the situations where tensions exist that would influence such a trade-off.

It is important to emphasise that March's (1991) work primarily focused on the inevitable trade-off between exploration and exploitation rather than on justifying the segregation of the two concepts. Because of this, his original proposition may lead to confusion and ambiguity in understanding and conceptualising exploration and exploitation. One example can be found in the definitional differences according to the focal point in the analysis. In his first model regarding internal modes of organisational learning, exploration and exploitation are defined as activities; whereas in the second model that includes analysis of environmental changes, exploration and exploitation are more suitable being defined as

strategic orientations of organisations. These differences and inconsistencies have been picked up by other literature reviews on the subject (e.g. Lavie et al., 2010, p. 142); for instance, conceptualisation and performance implications of exploration and exploitation.

It should not be forgotten that the approach that March (1991) adopted is theoretical modelling. This was not underpinned by empirical data. According to Almahendra and Ambos (2015, p. 24), proceeding studies have also failed to provide empirical support for his two models. Since adaptive processes are complex processes, his two 'simplified models' also lack conceptualisation from a meta-theoretical base (details about meta-theory will be discussed in Subsection 2.4.2). Without this meta-theoretical base and supporting empirical data, it can be argued that the notional separation of exploration and exploitation based on March's (1991) models lack both conceptual and empirical rigour.

2.2.2 Developments of Exploration and Exploitation

To explore the developments on exploration and exploitation, it would be interesting to see what further conceptualisation March has provided since his original work in 1991. Being recognised as another classic work in the topic, the paper by Levinthal and March (1993) can be considered as a supplement towards the original propositions made by March according to Almahendra and Ambos (2015, p. 10). By referring to 'the myopia of learning', Levinthal and March (1993, p. 105) conceptualise exploration as "*pursuit of new knowledge, of things that might come to be known*", and exploitation as "*use and development of things already known*". Moreover, this paper demonstrated different scenarios in decision-making of organisations where exploitation is likely to 'drive out' exploitation. This is regarded as a further specification of the trade-off between exploration and exploitation (ibid., pp. 105-107). However, the scenarios provided in the paper are rather descriptive and also without further empirical support. Hence, there is lack of justification provided on formulating the dichotomy.

Interestingly, using a similar definition as Levinthal and March (1993, p. 105), in a more recent paper, March (2006, p. 205) argued that "*exploitation without exploration leads to stagnation and failure to discover new useful directions. Exploration without exploitation leads to a cascade of experiments without the development of competence in any of them or discrimination among them.*" By making this claim, March (ibid.) indicated that firms need to achieve some degree of balance between exploration and exploitation. Nevertheless, it appears that this argument has implied the 'inseparable' nature of the concepts, because there

should not be a case where 'pure' exploration or exploitation exists. Therefore, discussing the two as separated constructs is not very helpful. However, this thinking is not elaborated in March (2006). Hence, although the later work from March has provided more theoretical arguments to demonstrate trade-offs between exploration and exploitation, there has not been any additional support in validating the separation of exploration and exploitation in addition to the original paper of March (1991).

Regarding the development to the two models stated in March (1991), studies have made few attempts of revisiting them to support the conceptualisation of this dichotomy. Referring back to the discussion in Subsection 2.2.1, March (1991) has included two conceptual models; one model considers internal organisational learning, whereas the other is linked to environmental dynamics. For the model focusing on internal organisational learning, Miller et al. (2006) have made an attempt to extend the model by adding factors for (1) allowing for direct interpersonal learning, (2) locating individuals in a space that makes the distinction between local and distant search relevant, and (3) recognising that knowledge has a tacit dimension that cannot be transmitted through codification. The rationale behind these extensions is the argument that two important aspects of organisational learning, namely interpersonal exchanges and tacit knowledge, are absent in the model proposed by March (1991). Based on a simulation, Miller et al. (2006, pp. 716-719) pointed out that their new model has examined and extended the propositions of March (1991). The difference shown in this model is that exploration is tied to distance search, whereas exploitation is associated with local search in organisations' search for knowledge. Local search is defined as changes in single dimension of an organisation's attributes and distant search means random draws from all possible combinations of attributes (ibid., p. 711). Also, these two types of search are discussed at both organisational and individual levels in their model.

In terms of the second model, Kim and Rhee (2009) have tried to extend it by the inclusion of internal variety and environmental dynamism (see definition of internal variety and environmental dynamism in Kim and Rhee [ibid., pp. 14-18]). Through a simulation, they have proposed that managing internal variety through combined managerial practices will contribute to a better management of exploration and exploitation. However, it appears that without considering the fundamental premises for the conceptualisation of exploration and exploitation, the two papers discussed here act only as an extension rather than a justification of the original model from March (1991). As a result, the original conceptualisation of exploration and exploitation and its later development still seem problematic; there should be alternative ways to view this notion by thinking beyond March (1991).

2.2.3 Thinking Beyond March (1991)

Closer examination of the references that March (1991) relied upon to develop his dichotomy shows that the separation between exploration and exploitation emerge from several disciplines, including economics, sociology, adaptive processes, business change and computing science. The study of Kuran (1988, p. 145) on conservatism in sociology points to a need to balance 'protecting expectations' and 'adapting to new environmental conditions'. This is similar to exploiting current knowledge or to searching for new alternatives. In March's (1991) list of references there are also studies on managers' behaviour for decision making (e.g. Kahneman and Tersky, 1979; Radner and Rothschild, 1975); the conflict that exists for decisions making is between certainty and uncertainty. This conflict, according to March (1991, p. 85), is the basic idea of the difference regarding outcomes of exploitation and exploration. Broadly speaking, the notion of exploration and exploitation has been discussed implicitly in different domains, until March articulated such conceptualisation in the context of management studies. Therefore, the distinction between exploration and exploitation is not entirely new or unique to March. But it is his abstraction and conceptualisation that has set the agenda for research into this dichotomy within the broader domain of organisation studies including innovation management.

In addition to the references that March explicitly used, there are also other studies implicitly discussing exploration and exploitation before 1991 that should be taken into consideration. More specifically, some studies have conceptualised exploration and exploitation as two connected phases in the same process. For example, in the model of Johnson and Jones (1957, p. 55) exploration appears as the first phase of new product development, whereas exploitation is mentioned in the test-marketing phase. In contrast, Tatum's (1987, p. 650) study on innovation in construction firms suggests that exploration and exploitation take place within the same stage of 'experiment and refine'. In this study, the activities of experimentation (underpins exploration) and refinement (referring to exploitation) are deemed to happen simultaneously. Broadly speaking, these views provide additional ways of looking at exploration and exploitation, different from March's (1991) interpretation.

Although the trade-offs between exploration and exploitation can be linked to the discussion of adaptation in evolutionary theories according to March (1991), Dekkers (2005, pp. 154-155) offers a different view on this link. He argues that by using meta-theoretical approaches, the current conceptualisation of exploration and exploitation differs from evolutionary models for organisations in the three following ways. First, he considers exploration and

exploitation as an expression of the criteria for evolvability and sustained fitness (see Kauffman, [1993, p. 95] for further description). Accordingly, exploration and exploitation are considered exerted, rather than as distinct internal processes. Second, even though exploration and evolvability express improving fitness of organisations, they are not exactly compatible in the evolutionary process. Third, exploitation can be considered a more limited concept for selection processes, because it may simply be the input and output of an organisation. Therefore, a more precise conceptualisation of exploration and exploitation may be needed to be consistent with generic evolutionary models for organisations.

To sum up, March (1991) has referred to some broad ideas and studies from different disciplines to conceptualise exploration and exploitation within the specific context of organisational learning. It is believed that March was not the first to propose this separation of exploration and exploitation, but his paper has made this dichotomy popular (Miller et al., 2006, p. 709). The later development based on this seminar paper fails to provide clarity on this notion. Besides his point of view, there are other studies that perceive this separation between exploration and exploitation differently. Consequently, this has generated some confusion and produced an inconclusive picture regarding the consequences of this dichotomy. Since March did not delve into why this distinction between exploration and exploitation was necessary, inevitably there is a need to clarify whether this presumed dichotomy holds real scientific validity. It is this point that creates the grounds for this study.

2.3 Justification of Research Context

The second task of this chapter is to discuss the research context of this study. This section will provide further justifications on the selection of the context of innovation management. Accordingly, the following subsections will first discuss what innovation management as the research context mean and the boundary that this study have drawn by defining innovation management, and then further elaborate why innovation management has been selected as the research context in this study.

2.3.1 Innovation Management as Research Context

The term ‘context of innovation management’ has been and will be mentioned several times in this thesis, hence, it is necessary to justify the meaning and scope of ‘innovation management’ in this study. Arguably, innovation involves knowledge from multiple disciplines, such as engineering, economics and sociology (Dodgson et al., 2014). In addition

to this understanding, scholarly knowledge regarding managing innovation often involves theories and ideas from other management areas. Taking the definition of Trott (2005, p. 15) as an example, innovation management is *"the management of all the activities involved in the process of idea generation, technology development, manufacturing and marketing of a new (or improved) product or manufacturing process or equipment"*. Although this definition does not include service innovation or business model innovation, it still reflects the fact that marketing of products or services, strategic management that enables innovation, and human resource management that facilitates innovation may all be affecting the success of managing innovation. Here, the successful developed product, process or service is regarded as innovation outcome.

However, it is still not clear that how the boundary should be drawn between innovation management and other management disciplines. According to the 'Oxford Handbook of Innovation Management', depending on its definition, innovation can both be regarded as an outcome and processes (Dodgson et al., 2014). Hence, innovation management is about establishing and managing internal processes or systems in organisations and based on managing these processes and systems to achieve positive innovation outcomes possibly in the forms of new products and services. Here, to ensure consistent using of wording, Table 2.2 provides an overview of the meaning of specific term this study will use relating to 'innovation'.

Table 2.2 Distinction of 'Innovation' Related Terms

Terms	Meaning
Innovation outcomes	New products or services, improved products or services that have been commercialised
Innovation processes	The internal processes of organisations that results in innovation outcomes
Innovation activities	Activities and practices that are included in innovation processes

This way of describing innovation management helps to make the distinction clear between innovation management and other related management domains. Table 2.3 provides an overview of the relationship and distinction between innovation management and other management contexts. The relevance and difference of these disciplines with innovation management are derived by how this study views these different disciplines.

Table 2.3 Overview of Management Disciplines

Management Disciplines	Relevance to innovation management	Difference with innovation management
Organisational Learning	· Knowledge management is critical for innovation · Organisational learning enables innovation · Organisational learning may be happening throughout the innovation process	· Organisational learning focused more on knowledge management rather than getting innovation outcomes · The focus of organisational learning is broader than innovation
Strategic management	· Strategic management provides a direction for innovation · Strategic management sometimes act as the starting point of innovation processes	· Strategic management covers all aspects of the operations of an organisation, innovation is just one part of this broader scope
Marketing management	· Marketing management is key for determine whether certain innovation outcome is successful or not · Market demand is one of the motives for innovation to happen	· Having different focus, marketing management are more focused on the commercialisation part of the innovation process, less attention is paid on how this innovation comes into place

To sum up these discussions, this study set the focus of the 'context of innovation management' as: (1) managing innovation activities for innovation outcomes and (2) managing internal organisational processes for innovation outcomes. In addition to this, product and service innovation will be included in the conceptualisation of 'innovation' in this study, whereas business model innovation is not. As a result, this defined context will be applied through the rest of the study.

2.3.2 Justification of Innovation Management in This Study

The previous subsection has discussed how this study considers innovation management as research context. This subsection will then further justify the implication of the context of innovation management in this study. Arguably, the most important reason to select the research context in innovation management is that studying exploration and exploitation in this context is more 'tangible'. Comparing to the likes of organisational learning or strategic management, the outcomes of innovation are easier to be identified and captured, because this is often in the form of products, processes, and services. Therefore, if the dichotomy of exploration and exploitation is valid in practice, it will be easier to observe them based on innovation management.

Besides, there are two additional reasons of setting innovation management as the research context. First, separating exploration and exploitation in innovation is questionable. A case in point arises from Drucker (1985, p. 67), who pointed out that tensions constantly exist between the need for certainty in decision making and the inevitable uncertainty of outcomes in relation to innovation. According to March (1991, p. 85), exploration is associated with uncertain outcomes, whereas exploitation is more likely to produce unambiguous results. In addressing this matter, Drucker (1985, p. 72) argues that successful innovation outcomes are the result of an accumulation of simple and focused experimental activities guided by a systematic management discipline. This means that innovation processes in its nature should include both exploration and exploitation, and therefore, exploration and exploitation should not be discussed separately. Second, organisational learning, for which this dichotomy was first proposed, is closely related to innovation management (see Table 2.2). Hence, there may be a good amount of literature discussing exploration and exploitation in innovation management.

As part of the scoping study, this study also reviewed the literature discussing exploration and exploitation in organisational learning, strategic management and marketing management. According to Lavie et al. (2010, p. 112), these are contexts where the dichotomy has been studied. This review can be found in Appendix I. The outcomes of this review suggested that current studies of exploration and exploitation have touched mainly upon topics, such as their conceptualisation, ways to manage them and how different approaches of managing them may influence organisations' performance. This study has drawn two key points from this review. First, it appears that current studies did not provide further justification to the use of this dichotomy in management. As mentioned in Subsection 2.2.3, this may lead to conflict outcomes of studies. Second, studies in exploration and exploitation have dispersed into different management disciplines, and within in each management discipline the conceptualisation is slightly different. Hence, although focusing solely on one management disciplines may lose some comprehensiveness, it would be beneficial to conduct this study in one context and examine the dichotomy in greater detail.

Consequently, this study argues that the dichotomy of exploration and exploitation is worth challenging and setting the research context in innovation management is beneficial to accomplish this task. However, this argument still needs further evidence to support. This means that without an in-depth review of current studies around exploration and exploitation in innovation management, it may be hard to determine whether setting this research agenda can make any contribution. This review will be the focus of Chapter 3.

2.4 Searching for New Research Agenda

The third task of this chapter is to elaborate on how the investigation of exploration and exploitation in the context of innovation management will unfold. To that purpose, this section will present some viewpoints that support the research agenda of this study. The method of problematisation is used assisting the search for new research agenda, a description of this method together with the reasons to use it can be found in Subsection 2.4.3. This is introduced late in the section because in order to justify the use of the method, the point 'types of assumptions' need first be discussed in Subsection 2.4.1 to provide more context of applying it. Based on the understanding of assumptions, the point of 'meta-theoretical reflection' is presented emphasising on the rigour of the new research agenda; this can be found in Subsection 2.4.2.

2.4.1 Understanding 'Assumptions' in Management Studies

Types of assumption is relevant to the discussion because what March (1991) formulated about exploration and exploitation may still be considered an assumed dichotomy (see Subsection 2.2.2). Hence, it is worth to see what 'assumption' means in management studies in more details. It is stated in 'The Oxford Handbook of Organisation Theory' (Knudsen and Tsoukas, 2005, pp. 4-6) that generalising for organisational theories is a process where researchers step back and reflect on 'ordinary theoretical activities' to make sense of the usefulness of relevant knowledge. Undoubtedly, this involves understanding and analysing certain assumptions (ibid.). Moreover, in what is now considered a classic, the critical sociologist Alvin Gouldner (1971) stated that social science can never achieve complete objectivity in its analyses. In emphasising this inevitable subjectivity, Gouldner was reiterating what the philosopher Alfred North Whitehead (1948, p. 183) insisted when he wrote that we are invariably indebted to the observational and conceptual orders we inherit, so that *"observational discrimination is not dictated by impartial facts. It selects and discards, and what it retains is rearranging in a subjective order of Prominence"*. What this means is that there is a pressing need for social scientists to strive to understand the social and psychological sources of their own biases. This process of understanding will then inevitably involve forming and making sense of assumptions. Arguably, considering the nature of social science or management studies, assumptions are crucial especially in terms of developing useful theories and generating new knowledge. Hence, the discussion on different types of assumption was included for a better justification on how exploration and exploitation were viewed.

More specifically, Davis (1971, p. 310) states that it is the involvement of challenging the assumption underlying existing theories that can make new theories notable and 'interesting'. However, it is not always appreciated that most of the underpinning assumptions in theories and conceptualisations, particularly in the social sciences, are unexamined. In terms of types of assumptions, Gouldner (1971, p. 29) argues that theoretical conceptualisation often entails two sets of assumptions: (i) postulations and (ii) background assumptions. Postulations refer to assumptions that are explicitly formulated, whereas background assumptions are defined as assumptions that are not expressly formulated but embedded in postulations. Considering the definition of these two sets of assumption. Gouldner (ibid.) further argues that postulations are generally the focal points of studies, and because of the 'unlabelled' nature of background assumptions, they normally receive less research attention. Based on the definition of background assumptions, domain assumptions are defined as the background assumptions that are applied in a single domain, which are narrower in scope compared to background assumptions. Hence, it is noted that although dealing with assumptions in management studies is considered important, the background assumptions may not be commonly examined.

The reasons that this study follows this distinction between different types of assumptions are as follows. First, background assumptions can be regarded as a link between different postulations, hence, it is influential throughout the processes of theory development (Gouldner, 1971). This means that background assumptions should be validated before a reliable theory is developed. Second, it is often determined by the acceptance of background assumptions that a certain theory is accepted in its specific context. If the background assumptions embedded in theories correspond the general beliefs of scholars viewing them, then these theories are more likely to be agreeable. Last, domain assumptions have a critical role in understanding certain management theories, and act as a link between theories and larger society. It is believed that domain assumptions should be 'intellectually consequential', which means new theories generated based on these assumptions should make sense (Gouldner, 1971, p. 35). In addition to these reasons, Gouldner (ibid., p. 32) further pointed out that in social science studies, scholars do implicitly use and are influenced by background and domain assumptions. This influence may reflect upon the research methodology and findings of empirical studies. Therefore, taking the viewpoint of the distinction on types of assumptions as premises, it may be beneficial that this study will not only focus on postulations that are explicitly formulated, but also on background and domain assumptions embedded in studying exploration and exploitation.

2.4.2 Thinking from Meta-Theoretical Perspectives

Due to the fact that theorising in the field of social science usually consists of a large amount, often unconnected, of paradigms and perspectives, 'scientific progress' in the field can be difficult and sometimes impossible (e.g. Anderson, 1983, p. 19; Martensson et al., 2016, p. 594; Wang et al., 2017, p. 1417). Hence, in order to ensure theoretical rigour in examining different types of assumptions in studying exploration and exploitation, the viewpoint of meta-theoretical reflection is referred to.

Stepping back from theories itself has led to the need of making clear what and how this study defines and conceptualises meta-theory and meta-theoretical perspectives. In management and organisational studies, concepts, theories and assumptions can be regarded as 'theoretical abstraction' (Love, 2000, p. 301). According to this interpretation, meta-theories can be considered as theories with a higher level of abstraction. A meta-theoretical perspective can be defined by its function, which is to understand and justify questions such as what knowledge is and how that knowledge can be translated into management practices (Knudsen and Tsoukas, 2005, p. 5). Accordingly, meta-theoretical reflection can be identified as stepping back from the original theoretical abstraction to view, examine and understand the usefulness of a certain management theory. This is then linked to not only looking at postulations, but also paying attentions to background and domain assumptions (see Subsection 2.4.1). Figure 2.1 briefly demonstrates the relationship between meta-theoretical reflection, theories and management phenomena. According to the figure, the objective level is mainly focused on describing what practices of management and organisations are about. This level concerns observation by the researcher and it only contains low level of abstraction of phenomena. Moving on to the theoretical level, it is noted that theories, models and frameworks are based on abstraction of the phenomena and observations from the objective level. In many cases, these observations and phenomena are the evidence for the abstraction of the theoretical level.

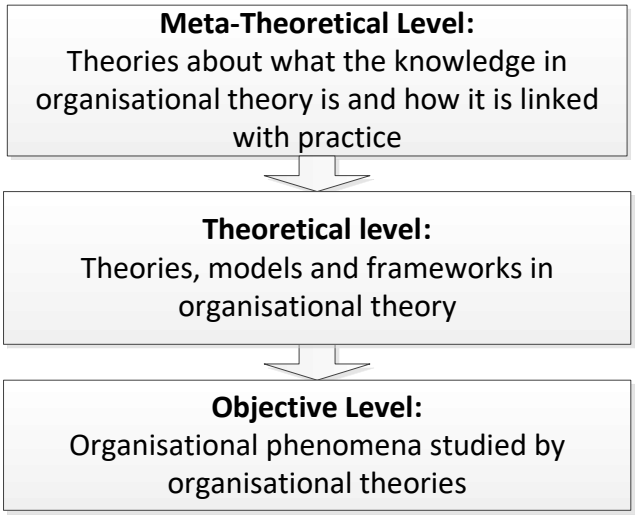


Figure 2.1 Meta-theoretical Reflection

This relationship between theoretical level and objective level may then bring up a philosophical argument known as 'justified true belief', which is used to describe beliefs that have been justified as true but not necessarily considered as knowledge (Gettier, 1963). In some case this problem refers to using one or two streams of evidence to justify a larger context, while the evidence that used is true and justified, the conclusion based on the evidence used may not be true or cannot be considered as knowledge; these situations are later described as 'justified true belief' sufficiency issues and that lead to the formulation of the 'Gettier problem' (Hetherington, 2018, p. 4).

In dealing with this problem, there may be a need for a reflection from meta-theoretical level on what knowledge is and whether the abstraction of theoretical level actually reflects what practice is like. However, one problem with this meta-theoretical reflection is that the processes of this reflection will never reach a point of a total perfection, because the Gettier problem may also appear in meta-theories. This means that there does not exist an ultimate common set of theories that can be acceptable as definite knowledge by everyone. Hence, this reflective process of abstract reasoning is inconclusive, but this reflection is still necessary. As a result, this study will still include the discussion from meta-theoretical perspective in later analysis. Linking with this study, there will be one review question set to understand the use of meta-theories in current studies (see Section 3.5 and Subsection 3.7.4 for more details). To be more specific the reasons to include meta-theoretical reflections are as followes. First, meta-theoretical reflection is beneficial in solving missing communication between certain theories and their audience. Adapting this reflection from meta-theoretical level sometimes help to make sense of management concepts in managerial practices (see Figure 2.1). Second, meta-theoretical reflection is helpful in validating

research outcomes. Meta-theoretical reflection can ensure the different types of assumptions to be viewed and tested not only by empirical evidence, but also by theoretical reasoning. Hence, reflection from meta-theoretical perspectives is considered in this study to be necessary.

2.4.3 Problematising for Research Agenda

To guide the process of finalising a research agenda, this subsection discusses briefly the method of 'problematising' proposed by Alvesson and Sandberg (2011) to evaluate whether the basic concepts of this method are applicable as points of reference for generating a novel research agenda by uncovering and challenging underlying assumptions.

Pointing out that the traditional way of 'gap spotting' in finding research questions has limitations, Alvesson and Sandberg (2011) proposed the method of 'problematising' that aims at generating novel research questions through challenging assumptions in current studies. Here, they (ibid., p. 253) have also referred to the different types of assumptions as discussed in Subsection 2.4.1. In addition, before they introduce the basic principle of this method, two categories of assumptions that may be suitable to be challenged are mentioned. The first one is about assumptions on how practice is described in theories, but such may not be the case in real world; the second is about assumptions on how different concepts are related, but in reality, it may not be. These two categories reflect similar idea to the Gettier problem discussed in Subsection 2.4.2. As discussed in the previous section, it seems that exploration and exploitation as separated activities in organisations may fit in the first category. Hence, a study into the topic of exploration and exploitation is applicable of using the method of problematisation. In addition to finding challengeable assumptions, Alvesson and Sandberg (2011, pp. 256-260) described 'problematising' in a methodological manner and summarised six steps to follow in applying this method, including identifying the domain of literature, identifying and articulating assumptions, evaluating articulated assumptions, relating assumptions to audience, and evaluating alternative assumptions; Table 2.4 presents some further details on these steps for applying 'problematising' with a link to this study.

Table 2.4 Steps for Problematising and Application to This Study

Steps	Description	Application to this study
Identify a domain of literature	What main bodies of literature and key texts make up the domain?	Studies in exploration and exploitation, with context further selected to be innovation management for a more detailed literature review.
Identify and articulate assumptions	What major assumptions underlie the literature within the identified domain?	This study relies on the viewpoint of different types of assumptions. Discussion on articulating the dichotomy of exploration and exploitation as assumption is presented in later Subsection 4.2.2
Evaluate articulated assumptions	Are the identified assumptions worthy to be challenged?	Discussed in Section 4.2 why assumptions behind exploration and exploitation are worth challenging.
Develop alternative assumptions	What alternative assumptions can be developed?	The dichotomy of exploration and exploitation does not make sense, the two concepts should not be discussed separated. Further discussion on this is presented in Subsection 4.2.3
Relate assumptions to audience	What major audiences hold the challenged assumptions?	This is applicable to all management constructs building upon the dichotomy, including the proposition of ambidexterity
Evaluate alternative assumptions	Are the alternative assumptions likely to generate a theory that will be regarded as interesting by the audiences targeted?	This will be answered through the fourth research question proposed in Section 4.3

Source: Alvesson and Sandberg (2011, pp. 256-260)

When using the method, it should not be ignored that applying 'problematising' is not without its limitations. As stated in Okimoto (2014, pp. 402-403) and relating to this study, 'problematising' may be difficult to conduct in a doctoral research, and also, there is lack of way to test the validation of the challenge on selected assumptions. However, applying the method of 'problematising' has the following benefits. First, compared to the traditional 'gap spotting' method, 'problematising' provides an in-depth understanding of the theories especially regarding assumptions, presenting a new way of analysing the reasons behind some confusion and conflicting results from existing studies. Second, compared to other

methods that are based on challenging existing theories or assumptions, 'problematising' provides a rather systematic approach for this study to follow (ibid., p. 400). Overall, it is fair to conclude that 'problematising' seems to fit the purpose of studying exploration and exploitation, and in the proceeding sections, principles from this method helps to validate the research agenda of this study.

2.5 Summary of Chapter 2

This chapter mainly provided further justification of conducting this study on the topic of exploration and exploitation in innovation management. Overall, this chapter has provided a scrutiny to the dichotomy of exploration and exploitation, justified the research context, pointed out some possible research gaps. Key points mentioned in this chapter are summarised as follows. Based on the scoping study in this chapter, an in-depth review of literature is expected to follow. The next Chapter will therefore present this review in a systematic manner.

- A relatively comprehensive understanding on what is exploration and exploitation is provided through a detailed analysis of the classic paper in the topic of March (1991).
- Some developments based on the dichotomy of exploration and exploitation are discussed, it appears that problems still exist in terms of the conceptualisation of this dichotomy these problems will be further specified in Section 4.2.
- Based on exploring alternative arguments on exploration and exploitation, limitations of the current understanding on exploration and exploitation are presented. This has led to why this study is necessary.
- Selecting innovation management as the research context has been further justified. The main reason lies in the 'tangibility' this context can provide in viewing exploration and exploitation
- Differences between postulations, background assumptions and domain assumptions is made, this is contributing to an in-depth understanding towards what may the 'problem' in studying exploration and exploitation may be.
- Meta-theoretical reflection and the Gettier problem then strength why there may be a 'problem', and by including meta-theoretical reflection this study aims to avoid the Gettier problem in theorising to some extent and to increase theoretical validity.
- Problematisation provides a method for this study to follow searching for novel research agenda based on challenging assumptions in current literature. This method will help this study to further articulate its research agenda later.

Chapter 3 Exploration and Exploitation in Innovation Management: A Systematic Literature Review

3.1 Introduction

Chapter 3 aims to offer an in-depth analysis of contemporary studies using the dichotomy of exploration and exploitation in the context of innovation management. Building on Chapter 2, with systematic approaches to review literature, the purpose of this analysis will be finding and justifying possible problems on the dichotomy of exploration and exploitation that exist in current studies. Hence, Section 3.2 will first describe the procedure that was used to undertake this literature review with systematic approaches. Based on some review questions proposed in Section 3.2, Sections 3.3 to 3.6 will present the results from a comprehensive analysis of the reviewed papers. This chapter will end with some discussion of these results that leads to formulating the further research focus of this study.

3.2 Systematic Approaches to Literature Review

This section discuss what systematic approaches to literature means and present some protocols of literature review in this chapter. Subsection 3.2.1 justifies the use of systematic approaches, and the following subsections demonstrate their implementations.

3.2.1 Taking a Systematic Approach to Literature

A systematic literature review refers to literature reviews that include replicable, scientific and transparent processes, providing as a complete list as possible of all studies relevant to addressing specific questions in a balanced and unbiased manner (Cronin et al., 2008, p. 2; Nightingale, 2009, p. 381; Tranfield et al., 2003, p. 209). Based on this definition, the main features of this type of review include: 1) a systematic approaches in searching, evaluating, selecting and analysing current studies, 2) a set of questions that guide the analysis of literature, and 3) an appropriate presentation of the discussion to pre-set review questions. With these features, evidence-informed management (scholarly) knowledge into the questions of interest is likely to be gained (Tranfield et al., 2003, p. 209).

Compared to other types of literature review, applying systematic approaches will be beneficial in the following aspects. First, the basic aim of this review is to see whether the use of the dichotomy in the context of innovation management has been challenged in existing studies (see Subsection 2.4.1). Hence, a relatively comprehensive inclusion of studies is helpful. Second, since this study has justified the focus on the context of innovation management (see Subsection 2.3), a systematic approach to literature will assist in identifying and relevant studies into the context. To some extent, this avoids the potential

confusion caused by conceptualisation of exploration and exploitation in other management domains. Third, this study follows the principles of 'problematisation' and views exploration and exploitation from its underlying assumptions. It will be helpful to review current studies with a set of review questions. This will provide a more in-depth analysis on selected studies. Hence, the following subsections will discuss its detailed application, including (1) setting review questions; (2) searching for appropriate papers; (3) developing and applying exclusion criteria. Papers selected for detailed analysis will be presented by the end of this section.

3.2.2 Setting the Review Questions

Addressing the aim of the literature review of investigating the validation of the dichotomy of exploration and exploitation in the context of innovation management, following questions are set to be addressed:

Review Question 1: For what purpose, both research and practice, has this dichotomy been used in the context of innovation management?

Review Question 2: What are the main perspectives of exploration and exploitation in studies of innovation management, and do any of these perspectives challenge the separation of these concepts?

Review Question 3: In the theoretical construction and use of this dichotomy, has there been any attempt to examine meta-theoretical presuppositions or referred to other theories?

Review Question 4: Empirically, what is the evidence base to sustain the notional separation of exploration and exploitation?

3.2.3 Searching for Relevant Papers: The Initial Stage

The search methods for relevant papers applied in this study are (1) using keywords for searching in selected databases and (2) snowballing. Here, snowballing means scanning through the references in papers to see if anything relevant is left out by the searches was used (Greenhalgh and Peacock, 2005). The first search method is chosen because it ensures inclusion of relevant studies. Furthermore, this can allow snowballing to be included as an additional step to ensure maximum coverage (ibid.). The process of applying the search method includes the following steps. First, appropriate keywords and search terms were determined as 'exploration and exploitation' and 'innovation'. To cover a maximum degree

of relevant papers, this study also considered possible alternative expressions and developed a Boolean expression for retrieving relevant papers as:

> *{['exploration and exploitation' OR 'exploration vs exploitation' OR 'exploration versus exploitation'] AND ['innovation' OR 'new product development' OR 'New service development' OR 'product design' OR 'product engineering' OR 'R&D' OR 'research and development']}*

This expression was applied to three databases: EBSCOhost, Google Scholar and Scopus. The selection of these three databases is based on the following consideration. First, using three databases is beneficial for the inclusion of relevant studies, preventing studies missing from specific databases (Green et al., 2006). Second, the databases selected are considered generic that are not tied to any specific publishers (examples of databases tied to publishers may be 'Emerald' and 'ScienceDirect'). This is also to ensure no relevant papers are missed due to the journal they are published in. This review set the 'stop signal' for each database. If 40 consecutive papers in the result shows no relevance to the study (based on the exclusion criteria presented in Subsection 3.2.4).

In addition to the searches in databases, snowballing techniques were adopted following guidance from Greenhalgh and Peacock (2005). Four papers that were not be captured by the keywords were included using this method. Further details on the search process are presented in Subsection 3.2.5.

3.2.4 Exclusion Criteria

After setting the search strategy, exclusion criteria were developed for selecting relevant papers. The exclusion criteria covered two points, the first is used for selecting papers from search results in databases and the second for selecting papers for detailed analysis. The first point considered the types of publication and scanning of the title and abstract of papers. Only journal papers were included, whereas books and conference papers were excluded. The initial selection of studies relied on reading abstracts. The second point is based on a detailed examination of papers focusing on their relevance to the research context of innovation management. As a result, in the initial stage of evaluation, 277 papers did bear relevance to this study with duplicates removed.

Table 3.1 provides detailed descriptions of the exclusion criteria applied with examples of papers removed from further analysis provided. Notably, the paper from Gibson and Birkinshaw (2004) was an exception to these criteria although it did not use the term

'exploration' and 'exploitation'. The reason for including this paper is that it is the origin of one of the major perspectives in dealing with exploration and exploitation (as will be discussed in Subsection 3.4.6), hence, analysing this paper against the four review questions may provide more insightful discussion to answering the questions.

Table 3.1 Exclusion Criteria

Exclusion Criteria	Example
Only marketing-orientated	*Kyriakopoulos and Moorman (2004)*
Only HR-orientated	*Litrico and Lee (2008)*
Only strategic management-orientated	*Ireland and Webb (2009)*
Only learning/knowledge-orientated	*Holmqvist, (2004)*
Conference papers	*de Visser et al. (2011)*
Unpublished working papers	*Masini et al. (2004)*
Literature reviews	*Gupta et al. (2006)*

3.2.5 Outcomes of the Systematic Approach in Selecting Papers

After the search and application of exclusion criteria, a total of 76 retrieved papers were identified for further analysis. Table 3.2 provides an overview of all the studies included in the analysis with the source of retrieval indicated. This search was conducted in the year 2016. The search in Google Scholar stopped at 17/05/2016 and the search in Scopus and EBSCOhost stopped at 14/06/2016. Studies published after the search dates are not included in this review to ensure consistency in terms of the outcome of the review with research design and empirical data collection in the later parts of this study.

Table 3.2 Retrieval Papers for Detailed Analysis with Duplication Removed

Data bases	Paper citation
EBSCOhost [17 papers]	Arvanitis and Woerter (2014); Benner and Tushman (2015); Blindenbach-Driessen and van den Ende (2014); Chandrasekaran et al. (2015); Choi and Phan (2014); Clausen et al. (2013); Garcia et al. (2003); Karhu et al. (2016); Kodam and Shibata (2014); Mudambi and Swift (2011); O'Cass et al. (2014); Suzuki and Methe (2011); Voss et al. (2008); Wei et al. (2014); Wang et al. (2015); Zacher et al. (2016); Zhou and Wu (2010)
Google Scholar [45 papers]	Andriopoulos and Lewis (2009, 2010); Atuahene-Gima (2005); Bauer and Leker (2013); Benner and Tushman (2002, 2003); Bierly et al. (2009); Brion et al. (2010); Carlisle and Mcmillan (2006); Cesaroni et al. (2005); Chang and Hughes (2012); Chang et al. (2011); Coradi et al. (2015); de Visser and Faems (2015); Fauchart and Keilbach (2009); Geiger and Makri (2006); Gilsing and Nooteboom (2006); Greve (2007); He and Wong (2004); Hernanedez-Espallardo et al. (2011); Hotho and Champion (2010); Jansen et al. (2005); Jansen et al. (2006); Jansen et al.

	(2009); Kim et al. (2010); Knight and Harvey (2015); Lee and Ryu (2002); Li et al. (2014); Lin and McDonough (2011); Lin et al. (2013); Lisboa et al. (2011); Liu and Leitner (2012); Matzler et al. (2013); McNamara and Baden-Fuller (2007); Nemanich et al. (2007); O'Reilly and Tushman (2004, 2011); Quintana-García and Benavides-Velasco (2008); Saetre and Brun (2012); Smith and Tushman (2005); UN (2007); Voss and Voss (2013); Wang and Rafiq (2014); Yalcinkaya et al. (2007); Yang and Li (2011)
Scopus [10 papers]	Cantarello et al. (2012); Durisin and Todorova (2012); Groysberg and Lee (2009); Kim and Huh (2015); Martini et al. (2015); Mcmillan (2015); Schamberger et al. (2013); Sok and O'Cass (2015); Wang and Jiang (2009); Yang et al. (2015)
Snowballing [4 papers]	Gibson and Birkinshaw (2004); Jansen et al. (2008); Papachroni et al. (2015); Tushman and O'Reilly (1996)

Overall, the results indicate the search and selection methods based on three databases was useful in two ways. First, there are studies included in the analysis that are published in journals not specific to innovation management domains. For example, Jansen et al. (2009) in The Leadership Quarterly, and Sok and O'Cass (2015) in the Journal of Service Marketing. Second, despite duplicates, all three databases together with the snowballing technique have contributed to the final list of papers for analysis. To sum up, Figure 3.1 provides a summary and some more details for each stages of the identification of suitable studies. The following section will briefly introduce how the detailed analysis took place.

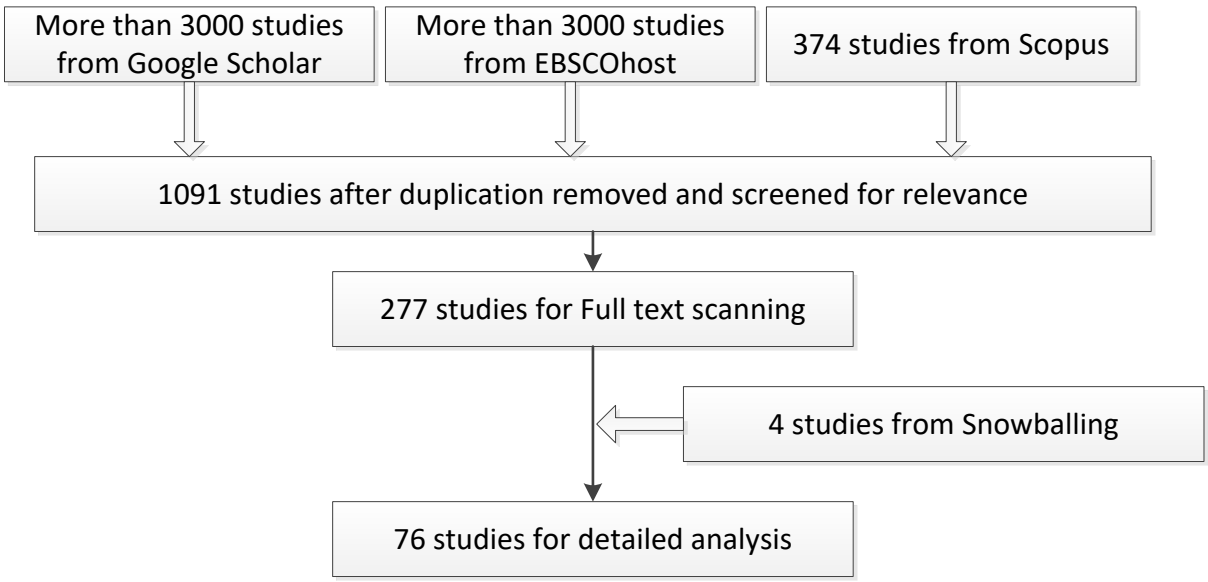


Figure 3.1 Paper Selection Process

3.2.6 Procedures for Detailed Analysis

Having identified the papers for analysis, three procedures were applied for a more systematic approach for analysing papers. First, the analysis is based on the four review

questions set in Subsection 3.2.2. Close attention has been paid to the definitions, perspectives, theoretical foundations and, if any, empirical evidence when analysing each paper. Second, a spreadsheet was developed recording relevant information from the papers. The information recorded in the spreadsheet includes title, year, source and research methods of the paper, and relevant arguments in papers relating to review questions. Part of this spreadsheet is presented in Appendix II. Third, new categories were added to the worksheet through the initial analysis of papers. For example, it appears that studies have referred differently to key statements that March (1991) made (see Subsection 3.3.4). Understanding how studies have referred to March (1991) may contribute to answering the first review question, and therefore, the citation pattern of studies in relation to postulations was added to the spreadsheet.

Besides the procedures discussed, it should be noted that this review did not include additional quantitative analysis, such as meta-analysis. The reason for this is that for the main purpose of this review, reasoning and logic plays a rather important role. Hence, this review will make efforts in categorising studies and present some quantitative results based on counting. With these settled, the following sections will present the results of the detailed analysis of the papers.

3.3 Analysis: Scrutiny Based on March (1991)

3.3.1 Citing of March (1991)

The importance and influence of March's (1991) work has been clearly stated in papers on exploration and exploitation (e.g. Bauer and Leker 2013, p. 199; Yang and Li 2011, p. 1444). Appendix II presents the citation patterns in full. A case in point is that 72 out of the 76 papers have cited March (1991) directly. Among the four remaining papers, Chandrasekaran et al. (2015, p. 134) and O'Cass et al. (2014, p. 862) relied mostly on the work that followed March (e.g. Atuahene-Gima, 2005; He and Wong, 2004). Hence these two papers can be classified as belonging to the same category as the 72 papers. Regarding the third of the four remaining papers, Cesaroni et al. (2005, p. 222) did use few references to support their theory building, but the understanding that organisations have scarce resources and decisions should be made between exploration and exploitation complies with March's (1991) postulation. The final of the four papers is O'Reilly and Tushman (2004). It appears to be more about story telling on how ambidexterity can be achieved in practice, hence it does not pay much attention to the conceptualisation of exploration and exploitation. Thus, it is

obvious that the work of March (1991) has had a deep and abiding influence on studies on exploration and exploitation in the context of innovation management. Therefore, it is necessary to examine this in greater detail.

Linking back to Subsection 2.2.2, it is clear that since the paper in 1991, March has made some development in conceptualisation of exploration and exploitation, especially Levinthal and March (1993), and March (2006). It will also be interesting to demonstrate the citation pattern on these two studies to see whether the studies into innovation management have followed the developments of the original conceptualisation. 49 out of the 76 papers have referred to the work from Levinthal and March (1993). In addition, although March (2006) is a relatively recent paper, there are only 8 out of 51 papers published after 2008 that include a citation to this work. Referring heavily to the original conceptualisation and without attention paid to the developments made by the original author may cause limitations when setting research objectives in later studies. However, what underpins this citation pattern will be looked at in later sections. The later subsections will focus on the influence from March (1991)

3.3.2 Influence of March (1991): Definitions

Generically speaking, the definition and description of March's (1991) dichotomy has been taken as the theoretical basis for the studies on exploration and exploitation in the context of innovation management. Some studies have applied the definition from March (1991) directly. For example, Visser and Feams (2015, p. 359) have used the same keywords to identify innovative activities within a firm that leads to their framework. Other studies have taken the basic ideas of March (1991) as broad guidance, developing different definitions associated with exploration and exploitation within certain contexts. For instance, Blindenbach-Driessen and van den Ende (2014, p. 1090) defined exploration as developing new products or services, whereas exploitation refers to improving existing operational processes in the firm. Their definition distinguishes between product and process innovation, which is different but has similar features to the definition of March (1991). Thus, despite studies clearly being influenced by March (1991), the way exploration and exploitation are differentiated from each other is inconsistent across studies even with their focus all being on innovation management.

More specifically, 39 out of the 76 studies have defined exploration and exploitation as different organisational activities (e.g. Arvanitis and Woerter, 2015; Suzuki and Methe 2011;

Zacher et al., 2016). This is the original way of defining exploration and exploitation. Some studies have discussed these concepts as activities within a specific context and include: learning and knowledge management (e.g. Coradi et al., 2015), innovation processes (e.g. Wang and Rafiq, 2014) and R&D projects (e.g. Bauer and Leker, 2013). There are 21 additional studies that defined exploration and exploitation as different types of innovation, based on the outcome of innovation. They refer to the differences in return of exploration and exploitation (e.g. Greve, 2007) and the distance to existing capability proposed by March (e.g. Hernández-Espallardo et al., 2011; Jansen et al., 2006). Other studies introduced additional dimensions for classifying types of innovation. For example, Clausen et al. (2013) referred to open exploration, closed exploration, open exploitation and closed exploitation. O'Cass et al. (2014) made a distinction between market and product exploration, and exploitation. Yet, other studies have conceptualised the notion differently, five as types of learning that underpin innovation outcomes (e.g. Kim et al., 2010), six as competence or capability (e.g. Yang and Li, 2011) and five as strategy or firm orientation (e.g. Fauchart and Keilbach, 2009). Table 3.3 presented the details in number of papers with similar ways of defining exploration and exploitation. Thus, it becomes clear that the dichotomy has been used very differently in the context of innovation management.

Table 3.3 Definition of Exploration and Exploitation

Definition	Studies
Organisational activities	Andriopoulos and Lewis (2009); Andriopoulos and Lewis (2010); Arvanitis and Woerter (2015); Atuahene-Gima (2005); Blindenbach-Driessen and van den Ende (2014); Brion et al. (2010); Cantarello et al. (2012); Carlisel and McMillan (2006); Choi and Phan (2014); Coradi et al. (2015); Durisin and Todorova (2012); Garcia et al. (2003); Glising and Nooteboom (2006); Groysberg and Lee (2009); He and Wong (2004); Hotho and Champion (2010); Karhu et al. (2016); Kodam and Shibata (2014); Lee and Ryu (2002); Lin et al. (2013); Lin and McDonough III (2011); Liu and Leitner (2012); Martini et al. (2015); Matzler et al. (2013); Mcmillan (2015); McNamara and Baden-Fuller (2007); Mudambi and Swift (2011); O'Reilly and Tushman (2004, 2011); Papachroni et al. (2015); Saetre and Brun (2012); Schamberger et al. (2013); Smith and Tushman (2005); Sok and O'Cass (2015); Suzuki and Methe (2011); Tushman and O'Reilly (1996); UN (2007); Visser and Feams (2015); Wang and Rafiq (2014); Zacher et al. (2010)
Types of innovation	Bauer and Leker (2014); Benner and Tushman (2002); Benner and Tushman (2003); Benner and Tushman (2015); Bierly at al. (2009); Chang et al. (2011); Chang and Hughes (2012); Clausen et al. (2013); Geiger and Makri (2006); Greve (2007); Hernandez-Espallardo et al. (2011); Jansen et al. (2005); Jansen et al. (2006); Jansen et al. (2008); Jansen et al. (2009); Kim and Huh (2015); Li et al. (2014); O'Cass et al. (2014); Voss et al. (2008); Wang et al. (2015)
Competence or capabilities	Gibson and Birkinshaw (2004); Knight and Harvey (2015); Lisboa et al. (2011); Quintana-Garcia and Benavides-Velasso (2008); Wang and Jiang (2009); Yalcinkaya et al. (2007); Yang and Li (2011);

Definition	Studies
Types of learning	Chandrasekaran et al. (2015); Kim et al. (2010); Nemanich et al. (2007); Wei et al. (2014); Yang et al. (2015); Zhou and Wu (2010)
Types of strategies	Cesaroni et al. (2005); Fauchart and Keilbach (2009); Voss and Voss (2013)

3.3.3 Influence of March (1991): Conceptual Model

Interestingly, despite March (1991) being widely cited, this review found no papers in the context of innovation management that directly build on his models of 'mutual learning' or 'knowledge and ecologies of competition' to develop their own theoretical framework. This is understandable considering models from organisational learning and innovation have different foci. Arguably, it may be the case that innovation management studies only use the idea of separating exploration and exploitation to establish their own research models rather than actually relying on them. Nevertheless, there are studies that attempted to develop the two models proposed by March (1991) (see Subsection 2.2.2). However, these attempts are all extending the models from March rather than challenging and validating the conceptualisation. Considering the focus of these papers is not specifically on innovation management, and, hence, this review will not go into more detail about them.

Nevertheless, some studies have been referring to the models of March implicitly, and examples can be found in the papers discussing the effect from the environment and competitive forces on exploration and exploration. For example, Jansen et al. (2005) argued that organisations combine or manage exploration and exploitation in response to dynamically competitive environments, and that it is possible to achieve a balance of the two activities in this environment state. Similarly, Yang and Li (2011, p. 14446) proposed that environment dynamism and competitiveness influence how organisations allocate resources to exploration and exploitation.

Notably, studies that are using environmental factors mainly consider it as moderating effects rather than justifying the original model that supports the distinction between exploration and exploitation. Similar to the inclusion of the influence from competition and environment, there are also studies discussing the role of knowledge in their framework. Greve (2007, p. 945) defined exploration as innovation activities that are searching for new knowledge, whereas exploitation consists of activities that use and refine existing knowledge. This way of thinking that exploration is searching, and exploitation is using knowledge is also reported in UN (2007, p. 5). It appears that the concept of knowledge has

mainly been applied to defining exploration and exploitation (this is similar to the work by Levinthal and March [1993]).

However, some of the considerations that March (1991) put forward have not been picked up by these studies. A case in point is the difference between firms competing to become first or avoiding being the last (ibid., p. 84). Also, considering knowledge, there are no studies making a distinction between organisational knowledge and individual knowledge to describe the processes of learning that enables individual knowledge aligning with organisational knowledge. Notably, this is the foundation of the conceptualisation of exploration and exploitation. Hence, studies referring to March (1991) only for the idea of separating exploration and exploitation tend to not provide further theoretical justification to the original model. In fact, this raises further doubts whether studies following March's (1991) conceptualisation have closely examined the suitability of his original propositions or not.

3.3.4 Influence of March (1991): Key Statements

For a more in-depth understanding regarding the influence of March (1991), six key statements made in March (1991) were noted, representing the key arguments in that paper. They are: A1) keywords that are associated with exploration and exploitation, A2) maintaining an appropriate balance between exploration and exploitation is primary factor in a system's survival and prosperity, A3) exploration and exploitation will compete for resources, A4) organisations will make choices, either explicitly or implicitly, about exploration and exploitation, A5) the essence and returns of exploration and exploitation are different, A6) increasing exploitation and reducing exploration make adaptive process potentially self-destructive. The reason to note these statements is that they may or may not have been used by proceeding studies. Table 3.4 presents the results on which studies are referring to which of these six statements made by March (1991).

Table 3.4 Influence of March (1991): Referring or Implication?

Code	Statements from March (1991)	Citations of Studies that followed
A1	**Exploration: search, variation, risk taking, experimentation, play, flexibility, discovery, innovation.** **Exploitation: refinement, choice production, efficiency, selection, implementation, execution.** **(March, 1991, p. 71)**	Atuahene-Gima (2005); Bauer and Leker (2014); Blindenbach-Driessen and van den Ende (2014); Choi and Phan (2014); Clausen et al. (2013); Coradi et al. (2015); He and Wong (2004); Hernandez-Espallardo et al. (2011); Jansen et al. (2008); Jansen et al. (2009); Karhu et al. (2016); Kim and Huh (2015); Knight and Harvey (2015); Matzler et al. (2013); Mcmillan (2015); Papachroni et al. (2015); Saetre and Brun (2012); Sok and O'Cass (2015); UN (2007); Visser and Feams (2015); Voss et al. (2008); Wang et al. (2015), Zacher et al. (2016)
A2	**Maintaining an appropriate balance between exploration and exploitation is primary factor in system survival and prosperity. (March, 1991, p. 71)**	Andriopoulos and Lewis (2009); Andriopoulos and Lewis (2010); Atuahene-Gima (2005); Bauer and Leker (2014); Benner and Tushman (2002); Benner and Tushman (2003); Bierly at al. (2009); Blindenbach-Driessen and van den Ende (2014); Brion et al. (2010); Carlisel and McMillan (2006); Cantarello et al. (2012); Chang et al. (2011); Chang and Hughes (2012); Choi and Phan (2014); Coradi et al. (2015); Durisin and Todorova (2012); Fauchart and Keilbach (2009); Geiger and Makri (2006); Gibson and Birkinshaw (2004); Glising and Nooteboom (2006); Greve (2007); Groysberg and Lee (2009); Hernandez-Espallardo et al. (2011); Hotho and Champion (2010); Jansen et al. (2005); Jansen et al. (2006); Jansen et al. (2008); Jansen et al. (2009); Karhu et al. (2016); Knight and Harvey (2015); Kodam and Shibata (2014); Lee and Ryu (2002); Li et al. (2014); Lin et al. (2013); Lin and McDonough III (2011); Liu and Leitner (2012); Martini et al. (2015); Matzler et al. (2013); Nemanich et al. (2007); O'Cass et al. (2014); O'Reilly and Tushman (2004, 2011); Papachroni et al. (2015); Quintana-Garcia and Benavides-Velasso (2008); Saetre and Brun (2012); Schamberger et al. (2013); Smith and Tushman (2005); Suzuki and Methe (2011); UN (2007); Visser and Feams (2015); Wang and Jiang (2009); Wang and Rafiq (2014); Wei et al. (2014); Yalcinkaya et al. (2007); Yang et al. (2015); Zacher et al. (2016)
A3	**Both exploration and exploitation are essential for organisations, but they compete for scarce resources. (March, 1991, p. 71)**	Arvanitis and Woerter (2015); Bauer and Leker (2014); Blindenbach-Driessen and van den Ende (2014); Cesaroni et al. (2005); Chang et al. (2011); Coradi et al. (2015); Garcia et al. (2003); Greve (2007); He and Wong (2004); Hernandez-Espallardo et al. (2011); Kim and Huh (2015); Lee and Ryu (2002); Li et al. (2014); Lin et al. (2013); Liu and Leitner (2012); Matzler et al. (2013); Mudambi and Swift (2011); Papachroni et al. (2015); Saetre and Brun (2012); Sok and O'Cass (2015); Suzuki and Methe (2011); UN (2007); Visser and Feams (2015); Voss et al.

		(2008); Voss and Voss (2013); Wang et al. (2015); Wei et al. (2014); Yang et al. (2015)
A4	**Implicit choice (of exploration and exploitation) are buried in many features of organisational forms and customs.** **Explicit choice (of exploration and exploitation) are found in calculated decisions about alternative investments and competitive strategies. (March, 1991, p. 71)**	Andriopoulos and Lewis (2009); Andriopoulos and Lewis (2010); Arvanitis and Woerter (2015); Bauer and Leker (2014); Benner and Tushman (2015); Brion et al. (2010); Carlisel and McMillan (2006); Cesaroni et al. (2005); Chandrasekaran et al. (2015); Choi and Phan (2014); Clausen et al. (2013); Garcia et al. (2003); Durisin and Todorova (2012); Geiger and Makri (2006); Gibson and Birkinshaw (2004); Greve (2007); Groysberg and Lee (2009); He and Wong (2004); Hotho and Champion (2010); Jansen et al. (2008); Jansen et al. (2009); Karhu et al. (2016); Kim and Huh (2015); Knight and Harvey (2015); Kodam and Shibata (2014); Lee and Ryu (2002); Li et al. (2014); Matzler et al. (2013); McNamara and Baden-Fuller (2007); Nemanich et al. (2007); O'Cass et al. (2014); O'Reilly and Tushman (2011); Papachroni et al. (2015); Schamberger et al. (2013); Sok and O'Cass (2015); Suzuki and Methe (2011); UN (2007); Visser and Feams (2015); Voss et al. (2008); Voss and Voss (2013); Wang and Jiang (2009); Yang and Li (2011); Zacher et al. (2016), Zhou and Wu (2010)
A5	**The essence of exploitation is the refinement and extension of existing competences, technologies, and paradigms. Its returns are positive, proximate, and predictable.** **The essence of exploration is experimentation with new alternatives. Its returns are uncertain, distant, and often negative. (March, 1991, p. 85)**	Andriopoulos and Lewis (2009, 2010); Arvanitis and Woerter (2014); Atuahene-Gima (2005); Benner and Tushman (2002); Benner and Tushman (2003, 2015); Bierly et al. (2009); Blindenbach-Driessen and van den Ende (2014); Brion et al. (2010); Cantarello et al. (2012); Carlisle and Mcmillan (2006); Chandrasekaran et al. (2015); Chang and Hughes (2012); Chang et al. (2011); Choi and Phan (2014); Clausen et al. (2013); Fauchart and Keilbach (2009); Garcia et al. (2003); Geiger and Makri (2006); Gibson and Birkinshaw (2004); Gilsing and Nooteboom (2006); Greve (2007); Groysberg and Lee (2009); He and Wong (2004); Hotho and Champion (2010); Jansen et al. (2005); Jansen et al. (2006); Jansen et al. (2008); Jansen et al. (2009); Kim and Huh (2015); Kim et al. (2012); Kodam and Shibata (2014); Lee and Ryu (2002); Li et al. (2014); Lin and McDonough (2011); Lin et al. (2013); Lisboa et al. (2011); Liu and Leitner (2012); Martini et al. (2015); Matzler et al. (2013); Mcmillan (2015); McNamara and Baden-Fuller (2007); Mudambi and Swift (2011); Nemanich et al. (2007); O'Cass et al. (2014); Papachroni et al. (2015); Quintana-García and Benavides-Velasco (2008); Saetre and Brun (2012); Schamberger et al. (2013); Smith and Tushman (2005); Sok and O'Cass (2015); Suzuki and Methe (2011); Voss and Voss (2013); Voss et al. (2008); Wang and Jiang (2009); Wang and Rafiq (2014); Wang et al. (2015); Wei et al. (2014); Yalcinkaya et al. (2007); Yang and Li (2011); Yang et al. (2015); Zhou and Wu (2010)

A6	**Increase exploitation and reduce exploration make adaptive process potentially self-destructive (March, 1991, p. 73)**	Andriopoulos and Lewis (2009); Arvanitis and Woerter (2015); Benner and Tushman (2002); Carlisel and McMillan (2006); Chang and Hughes (2012); Fauchart and Keilbach (2009); Greve (2007); Hernandez-Espallardo et al. (2011); Hotho and Champion (2010); Karhu et al. (2016); Kim and Huh (2015); Lin et al. (2013); Liu and Leitner (2012); Nemanich et al. (2007); Papachroni et al. (2015); Yang et al. (2015); Yang and Li (2011)

According to Table 3.4, there are three main points worth noting with implications for outcomes of studies. First, it seems that A3: 'organisations should have both exploration and exploitation activities' (56 out of 76 papers) and A5: 'the essence and returns of exploration and exploitation are different' are the two most accepted claims (63 out of 76 papers). This also appears to be the most used combination for the key statements (13 out of 76 papers). The possible reason behind this is that no matter how studies define and view exploration and exploitation, these two statements provide the reason for doing research in this manner. Since both exploration and exploitation are seen as important for organisational success (e.g. Andriopoulos and Lewis, 2009 p. 696; Gilsing and Nooteboom, 2006, p. 3; Greve, 2007, p. 945), but are different in terms of essence and returns, they might require different organisational forms and structures (Chang and Hughes, 2012, p. 3; Jansen *et al*., 2005, p. 353). Therefore, these arguments suggested that further studies should look into how to sustain exploration and exploitation simultaneously.

Second, the keywords that March (1991) used to capture exploration and exploitation are not commonly followed by studies (only 23 out of 76). This is relatively low compared to the most cited postulations as A2 (56 out of 76 papers), A4 (45 out of 76 papers) and A5 (63 out of 76 papers). This implies that subsequent studies are developing new conceptualisations, which also leads to differences in defining exploration and exploitation. Nevertheless, although using the keywords March (1991) proposed in defining exploration and exploitation has limitations, it is still an important part in the overall conceptualisation of the dichotomy in studies. This is to say that, formulating the other postulations may rely on the keywords he proposed and act as outcomes from a logic deduction of statement A1. Since low citation rate on A1, and high citation rate of the other postulations, this study argues that some new definitions studies proposed are just to fit more accurately the other statements. In this sense, these 'new' definitions may lose their validity because the conceptualisation process only looks at finding fits for possible features of exploration and

exploitation. Overall, this state of how studies use different postulations may be one of the main reasons in the inconsistency of conceptualising exploration and exploitation.

Last, although most studies have not considered all points made by March (1991), his work has still had a significant impact on subsequent studies. One obvious example is that following the argument 'exploration and exploitation will compete for resources', studies have been inspired to investigate resource allocation. This is also linked to making choices about the two activities in organisations. Therefore, different combinations of the six statements of March (1991) have resulted in different foundations for studies into exploration and exploitation. This may explain the wide variety research outcomes across retrieved studies (see Section 3.6 for evidence). For example, if a study takes the point that both exploration and exploitation are important, and they are different but not to the point that they will compete for resources, this study may end up discussing ambidextrous organisations rather than resource allocation. As a result, the differing adoption of March's assumptions will lead to different perspectives on exploration and exploitation and varying outcomes across studies using the dichotomy.

When analysing the patterns of citations, there are three additional points worth mentioning. First, there are only two studies that cite and refer to all six key statements (Greve, 2007; Papachroni et al., 2015). This is understandable since all these statements made by March (1991) suit mostly the research purpose for his paper. Hence, to construct their own research, it is possible that studies chose to refer to postulations that fit their own research aims. Second, the two most popular patterns of citation are A2 and A5 (with 13 papers) and A2, A4 and A5 (with 8 papers). As previously discussed, A2, A4 and A5 received the highest number of citations, and the combination of A2 and A5 leads to underpinning logic of doing research in exploration and exploitation from the perspective of the dichotomy. Studies that include A4 in addition to the combination of A2 and A5 elaborate more on how organisations can control or manage an appropriate balance between exploration and exploitation (e.g. Groysberg and Lee, 2009, p. 752; Schamberger et al., 2013, p. 349). However, the main arguments made here are still similar to studies with the combination of A2 and A5. Third, there are 29 patterns identified in retrieved studies, expected for the two most popular ones just mentioned. It appears that the distribution of studies citation patterns is rather even, in other words, different studies tend to use different combinations of postulations from March (1991) in constructing their research. Again, this observation may explain differences in conceptualising the dichotomy, perspectives taken towards exploration and exploitation, and also the outcomes of studies.

To sum up the discussion in this section focused on how the work from March (1991) influenced subsequent studies into innovation management, especially in terms of conceptualisation. Most of the studies into innovation management have used March's (1991) paper, and this paper is having a significant impact on later studies. However, additional analysis showed that studies are referring to March (1991) because this paper is considered as the classic in the domain. It seems that in terms of conceptualisation, there have not been challenges raised to viewing exploration and exploitation as a dichotomy. The next section will look at different perspectives that studies took on exploration and exploitation and whether this challenge exists in any of these perspectives.

3.4 Analysis: Shifting Paradigms in Current Debate?

3.4.1 Managing Exploration and Exploitation

The previous discussion indicates that although the majority of papers have taken the work of March (1991) as a starting point for their analysis, there are still different views on how exploration and exploitation should be managed in organisations. Yet, the common understanding, including the work of March (1991), is that exploration and exploitation, no matter in what form, both exist within an organisation. Therefore, organisations cannot focus exclusively on either exploration or exploitation, because solely relying on one will lead to organisations not able to survive in the long-term (March, 1991, p. 85).

This point has been further discussed in many studies. For example, Geiger and Makri (2006, p. 98) proposed that exploration and exploitation both play important part in innovation processes. Similarly, Chandrasekaran et al. (2015, p. 579) indicated that no matter in the situation of radical or incremental innovation processes, exploration and exploitation will have a joint effect on the innovation outcomes. Under these understandings, the discussion about the notions has mainly been on how both exploration and exploitation should be managed or balanced in the organisation. This has resulted in different perspectives to it. It is then necessary to investigate each perspective in more detail to see whether any of the perspectives has embedded challenges to the validity of the dichotomy from March (1991).

3.4.2 Perspective: Classical Trade-off

Starting from the perspective that is close to the proposition of March, the classical trade-off perspective implies that the focus on either exploration or exploitation will likely drive out the other (March, 1991, p. 85). Some studies even used a simple equation to demonstrate

this perspective as ‘exploration = 1 - exploitation’ (Bauer and Leker, 2014, p. 202). This perspective is based on the view that exploration and exploitation will compete for constrained organisational resources and the existing tensions between the two make it impossible for organisations to maintain a relatively high level of allocation for both. The idea of this so-called ‘classical trade-off’ perspective has been adopted by studies that especially focused on resource allocation. For example, Bauer and Leker (2013, pp. 207-209) studied how to allocate budgets to exploration and exploitation activities and found the need to make a distinction between product and process innovations associated with exploration and exploitation. Furthermore, they proposed that there is an appropriate ratio of how organisations should assign budget to either activities, which would boost innovation performance. Similar outcomes can be found in other studies that focused on resource allocation, such as Kim and Huh (2015) and Visser and Feams (2015). The common understanding here is that organisations can achieve a higher innovation performance by allocating their budget wisely.

It seems reasonable that the ‘classical trade-off’ still holds its ground in many study contexts considering there is still a need to understand how organisations should allocate resources to improve performance. In order to do so, studies have to make it clear on how they distinguish between exploration and exploitation. However, it is noted that studies that did take this perspective failed to provide further justification on the separation of exploration and exploitation, and did not proof that organisations actually allocate their resources based on this separation.

In addition, the perspective itself has considerable limitations. First, considering the scope of how ‘resources’ should be defined in organisation. For example, if information and knowledge are treated as resources in organisations, then such resources may be more suited to be considered infinite rather than finite (Gupta, et al., 2006, p. 695). Second, moving beyond resource allocation, logic-wise, it seems that this perspective considers exploration and exploitation as a ‘zero-sum’ game. This means that the gain or loss from exploration is exactly balanced with the loss or gain from exploitation or vice versa; see for example Binmore (2007, p. 216) and Bowles (2004, p. 37) on definition of zero-sum game. Not only is it difficult to identify what is actually gained or lost from exploration and exploitation, but the interaction and ‘joint effect’ of exploration and exploitation has also been identified by studies (e.g. Li et al., 2014; Zacher et al., 2016). This joint effect indicates a possible non-zero-sum game for exploration and exploitation. However, the classic trade-off perspective ignores this situation. Therefore, with the conceptualisation of exploration and exploitation

still questionable, it is argued that classic trade-off fails to provide a justification for validating the dichotomy.

3.4.3 Introducing Ambidexterity into Consideration

Considering the limitations from the classical trade-off perspective, studies have introduced the idea of ambidexterity in searching for a new way to manage exploration and exploitation. The term ambidexterity was originally used to describe people with the ability to use both their hands in an even manner (Maier, 2015, p. 1). In the context of management studies, it generally refers to organisations that are able to do two things simultaneously but without losing any of the quality of each one. Linking this definition with how organisations could survive in the increasingly intensive competition, Duncan (1976) made the first attempt to introduce the concept of 'ambidextrous organisations' into management studies. However, it was not until March's (1991) contribution on the topic of exploration and exploitation, that there was any serious effort made to investigate the concept of ambidexterity; in this regard, ambidexterity is conceptualised and directly linked to the management of exploration and exploitation (O'Reilly and Tushman, 2013, p. 325). Consequently, it is believed by many that organisations can achieve ambidexterity by managing the tension between exploration and exploitation appropriately (ibid., p. 327).

Taking a closer look at Duncan (1996) first, he proposed that organisations should design a dual structure that can shift depending on different circumstances to support innovation. These organisations that are able to support this dual structure should be referred to as being ambidextrous. Combining the idea of ambidexterity with exploration and exploitation, Tushman and O'Reilly (1996) proposed that exploration and exploitation can happen simultaneously, and organisations that achieved this are called ambidextrous organisations. This view has inspired a large number of studies to investigate under what conditions ambidexterity can become useful, and also to look at its impact on organisational performance and longevity (O'Reilly and Tushman, 2013). In addition, studies are keen to know how an organisation can achieve ambidexterity. However, based on different perspectives on exploration and exploitation, there is little agreement on how ambidexterity should be achieved. Hence, in the next few subsections, this study will discuss the different theoretical ways for achieving ambidexterity. Notably, the question still remains whether any of these perspectives has challenged the dichotomy of exploration and exploitation or provide a solid justification for the dichotomy.

3.4.4 Perspective: Temporal Ambidexterity

According to Duncan (1976, p. 180), organisations should adapt their structures based on changes to environments over time, this is later being defined as temporal ambidexterity. Temporal ambidexterity posits that to achieve a balance on exploration and exploitation, organisations must shift their focus to either one or another over time (Nemanich et al., 2007, p. 103; Liu and Leitner, 2012, p. 106). The main reasons behind the proposition of this perspective is that organisations may find it hard to undertake both activities simultaneously. Therefore, not achieving a balance between exploration and exploitation over time may prove problematic (Carlisel and McMillan, 2006, p. 3; Hotho and Champion, 2010, p. 43).

Studies using the temporal ambidexterity perspective usually emphasise how an organisation can or ought to shift from exploration to exploitation, or vice versa. Nemanich et al. (2007, p. 353) took exploration and exploitation as conflicting innovation strategies and proposed that a balance can be achieved only over time. They further illustrate a conceptual model demonstrating that the shift of these two strategies can be achieved through different leadership approaches, yet, as a conceptual paper, there is no empirical evidence validating their model. Similarly, based on the evidence that R&D investment of organisations shows significant fluctuations over time, Mudambi and Swift (2011, p. 437) proposed that organisations do shift their focus between exploration and exploitation. In addition to this changing focus, Gilsing and Nooteboom, (2006, p. 3) presented a model where the shifting between exploration and exploitation happens in a cycle, and that prior exploration or exploitation will have an ‘extended’ impact on the sequential exploitation or exploration stage. Their argument implies that organisations will make decision on their ongoing activities based on past performance of exploration and exploitation. Based on this model, they argued that exploration and exploitation are able to build on each other.

According to the basic arguments in temporal ambidexterity, reasons behind the shifting is often dependant on the external environment and economic cycles (e.g. Gilsing and Nooteboom, 2006; Nemanich et al., 2007). Studies into innovation management have proposed that balancing exploration and exploitation through time is beneficial especially when the business environment is in a volatile state or the industry is changing at a fast peace (Greve, 2007, pp. 967-968; Mudambi and Swift, 2011, p. 437). In evaluating this perspective, it seems that there is a lack of evidence sustaining the usefulness of temporal ambidexterity.

Despite the fact that their definition of exploration and exploitation being highly questionable, Hotho and Champion (2010) offer an interesting case study for a computer gaming company, which demonstrates organisational shifting from ‘work for hire’ (which they categorise as exploitation) towards ‘invest in intellectual property’ (as exploration). However, by the end of their case study, this company has been reported to suffer a great loss. This has raised questions on whether temporal ambidexterity is actually useful. Nevertheless, this is the only evidence that this review was able to find that shows temporal ambidexterity in practice. Other studies generally failed to provide support on how organisations actually choose to shift their focuses or whether they are balancing over time. To sum up, the basic arguments derived from evidence from temporal ambidexterity still heavily rely on the separation of exploration and exploitation, and the related tension between the two; hence, this perspective does not seem to be providing any challenges to the dichotomy.

3.4.5 Perspective: Structural Ambidexterity

Taking a similar stance as temporal ambidexterity, studies that considered exploration and exploitation needing simultaneously support from differentiating organisational structures have pointed out the structural ambidexterity approach. The structural ambidexterity perspective indicates that the conflict this dichotomy brings is significant and organisations can create different organisational units (with unique architectural and cultural design) to facilitate exploration or exploitation. Therefore, having different exploration-focused and exploitation-focused units enables organisations to find a balance; see for example, Smith and Tushman (2005, p. 524). This perspective is first proposed by Tushman and O'Reilly (1996), where they argued that structural ambidexterity refers to organisations that are able to form highly differentiated units that have specific targets for either exploration or exploitation. These units are internally consistent in terms of culture and management style, but among the units there should be differentiated in activities pursued. (ibid, p. 26). Studies further suggest that exploitation units are often centralised with tight control from managers and culture, whereas exploration units are often associated with decentralised structures, loose culture, less controls, and flexible processes aiming at enabling creativity and innovation through experiments (Benner and Tushman, 2003, p. 248).

Taking into account the principles for building separate organisational units to balance exploration and exploitation, innovation management studies have also considered how management styles can enable this separation. For example, Smith and Tushman (2005, p.

529) proposed four factors that allow managers to successfully design and manage this structural separation: 1) distinct roles, goals, and rewards; 2) supportive integrators; 3) extensive leader-member interactions; and 4) leader coaching to focus on the product level and avoid conflict. Similarly, Jansen et al. (2008, p. 999) argued that a senior team shared vision, transformational leadership and contingency rewards will allow organisations to successfully managing the separate units. However, they did not demonstrate how exactly these units (if they do exist at all) are supported. Therefore, it appears that these managerial attributes that should enable structural separation are in fact quite descriptive and lack any real empirical evidence. There is no evidence that organisations intentionally create these units and manage each unit with specific a focus on either exploration or exploitation.

The proposition of structural ambidexterity is based on the understanding that undertaking exploration and exploitation requires different organisational designs, which are influenced by management styles and cultures. Hence, to avoid the potential conflict in pursuing these two conflicting, yet necessary activities separated into different units with different foci seems to be an 'obvious' answer. The logic behind the proposition of this perspective seems to be understandable, however, with further evaluation, structural ambidexterity seems problematic. Not only there is limited evidence supporting the effectiveness of this approach, but it may also be impossible to identify a unit in any organisation that is purely directed at exploration or exploitation.

The idea of establishing a structural ambidextrous organisation itself ignores the interaction between exploration and exploitation, and assumes that exploration and exploitation can successfully be implemented without each other. This is contradicted by the further development of the dichotomy March (2006) has made (see Subsection 2.2.2). Overall, structural ambidexterity only offers an 'easy' solution to managing the tension between exploration and exploitation. It does not provide a challenge to the dichotomy of exploration and exploitation.

3.4.6 Perspective: Contextual Ambidexterity

Based on the discussion of the three perspectives so far, it seems that these perspectives have heavily emphasised the tensions between exploration and exploitation. However, alternative arguments suggest that different treatments could be available for enabling the interaction between exploration and exploitation. As a result, the idea of contextual ambidexterity is proposed. First introduced by Gibson and Birkinshaw (2004), the basic idea of contextual

ambidexterity referred to the abilities of organisations to effectively balance exploration and exploitation by creating a suitable context within the organisation based on stretch, discipline, support, and trust. The 'context' here has been defined as "*systems, processes, and beliefs that shape individual-level behaviours in an organisation*" (ibid., p. 212). Notwithstanding Gibson and Birkinshaw (ibid., p. 210) proposed contextual ambidexterity using the concepts of alignment and adaptability, this perspective has been taken and applied by studies based on exploration and exploitation.

One important aspect to consider, when talking about contextual ambidexterity is what kind of organisational context for organisations needs to be created. From other studies followed up this perspective, it can be derived that these contexts may include but are not limited to culture (e.g. Wang and Rafiq, 2014), leadership (e.g. Lin and McDonough, 2011) and cognitive style of top managers (e.g. Karhu *et al.*, 2016). Taking culture as an example, Yang et al. (2015, p. 761) argued that a collectivistic culture setting in organisations can allow organisations to managing a balance between exploration and exploration and achieving ambidexterity. With a different stance, Wang and Rafiq (2014, p. 74) suggested that the cultural context for ambidextrous organisations is a "*higher-order construct consisting of organisational diversity and shared vision*". From these two examples about culture, it appears that it is still difficult for studies to draw a clear conclusion of what should the 'context' be for achieving contextual ambidexterity.

Moreover, studies suggested that it is easier for individuals than organisations as a whole to balance attributes such as creativity, quality and attention. Therefore, studies based on this perspective take great account of individual behaviours in organisations (Groysberg & Lee, 2009; Lin et al., 2013; UN, 2007). For example, front-line staff, senior managers and top-management teams can choose different approaches to a task that allows an emphasis on both creativity and quality. This implies that individuals within the organisation are able to change their behaviour between exploring and exploiting to improve their work performance, and eventually contributing to innovation outcomes in the given context.

It appears that contextual ambidexterity has become a well adopted approach by studies into exploration and exploitation since proposed. When compared contextual structural or temporal ambidexterity, the former suggests that achieving ambidexterity does not necessarily require 'physical' changes within organisations. The basic argument of contextual ambidexterity is that organisations should focus more on creating a supportive environment for individuals rather than tightly controlling activities and searching for a

balance. Here, this 'context' that organisations should create is the key for the success when achieving ambidexterity. This is arguably a step forward from the trade-off for exploration and exploitation, because contextual ambidexterity supports the interaction between exploration and exploitation. This implies no separation between exploration and exploitation at least at the organisational level. Although studies have claimed that their results support contextual ambidexterity in practice (e.g. Wang and Rafiq, 2014, p.70), there is still lack of evidence of whether organisations are using this approach, and whether it actually does work as an effective way dealing with the exploration and exploitation.

Scrutinising the basic ideas of contextual ambidexterity, this study argues that it is impossible to know whether contextual ambidexterity is actually working for organisations. Studies could prove organisations that have applied certain 'contexts' might be aiming to achieve contextual ambidexterity, resulting in performance improvement of innovation. However, this does not mean that contextual ambidexterity is working. Since, the main focus of this perspective is on individual behaviour, it is nearly impossible to know whether, for example, an exploration outcome is achieved only by an exploration activity. In addition, it may even be impossible to define exploration and exploitation based on the level of individual behaviour. As a result, contextual ambidexterity may always remain a theoretical argument without further empirical support. Consequently, instead of challenging the original dichotomy, this perspective raises additional questions about the conceptualisation of exploration and exploitation on the level of individual behaviour, and thus, that may lead to more confusion.

3.4.7 Perspective: Paradoxical Thinking

The paradox perspective is increasingly considered to offer a highly comprehensive approach for enabling interactions between exploration and exploitation. The main focus of this perspective is based on accepting the tension between exploration and exploitation. By taking a paradoxical way of thinking, the paradox perspective calls for a change of managerial mind-set from 'either … or …' towards 'both … and …'. Though it is still in its as early stages in terms of development and application, the general argument of a paradox perspective is encouraging the development of certain organisational form that enables the transcendence of paradoxes and pursuit of both paradoxical activities (Papachroni *et al.*, 2015, p. 87). The scope of paradoxical thinking is not necessarily limited to exploration and exploitation in the first place. An example of another discussion on paradoxical thinking in

organisations include novelty and usefulness in outcomes of searching for creativity (Miron-Spektor and Erez, 2017).

Andriopoulos and Lewis (2009) first applied this way of thinking to exploration and exploitation, viewing the dichotomy as paradoxical. More specific, studies using this perspective favour differentiating and integrating exploration and exploitation simultaneously and searching for balance at different levels within organisations over time (e.g. Knight and Harvey, 2015; Papachroni *et al.*, 2015). Moreover, viewing exploration and exploitation from a paradoxical view may require managers to not force their organisations to explore or exploit. Instead, it arguably calls for managers to build up capabilities to deal with the competing demands and tensions caused by this dichotomy in innovation (Andriopoulos and Lewis, 2009, p. 709; Papachroni *et al.*, 2015, p. 88). However, the development of applying this perspective is still in its early stages with only a few papers taking it was found. This is to say that it is still not clear how organisations can apply paradoxical thinking in managing exploration and exploitation with clearer guidelines. Since this is considered to be a recent trend in the debate, further studies into the actual conceptualisation and implementation are still necessary.

3.4.8 Overview of Major Perspectives

With the analysis on main perspectives that studies have taken in studying exploration and exploitation presented, Table 3.5 provides an overview of papers for each of the five perspectives. Note that not all studies have demonstrated a clear position in a certain perspective and thus the intention of the figure and the table is not to fit every paper into perspectives.

Table 3.5 Main Perspectives on Exploration and Exploitation

Main Perspectives	Used by papers
Classic trade-off	Arvanitis and Woerter (2015); Bauer and Leker (2014); Bierly at al. (2009); Cesaroni et al. (2005); Choi and Phan (2014); Chang et al. (2011); Fauchart and Keilbach (2009); Garcia et al. (2003); Geiger and Makri (2006); Hernandez-Espallardo et al. (2011); Kim et al. (2010); Kim and Huh (2015); Li et al. (2014); Mcmillan (2015); Matzler et al. (2013); Quintana-Garcia and Benavides-Velasso (2008); Suzuki and Methe (2011); Visser and Feams (2015); Voss et al. (2008); Yang and Li (2011)
Structural ambidexterity	Benner and Tushman (2003, 2015); Blindenbach-Driessen and van den Ende (2014); Chang and Hughes (2012); Greve (2007); Jansen et al. (2008); Liu and Leitner (2012); O'Reilly and Tushman (2004); Martini et al. (2015); O'Reilly and Tushman (2011); Smith and Tushman (2005); Tushman and O'Reilly III (1996); Yang et al. (2015)
Temporal separation	Carlisel and McMillan (2006); Glising and Nooteboom (2006); Greve (2007); Hotho and Champion (2010); Lee and Ryu (2002); Liu and Leitner (2012); McNamara and Baden-Fuller (2007); Mudambi and Swift (2011); Nemanich et al. (2007)
Contextual ambidexterity	Benner and Tushman (2015); Brion et al. (2010); Cantarello et al. (2012); Chandrasekaran et al. (2015); Gibson and Birkinshaw (2004); Groysberg and Lee (2009); Jansen et al. (2005); Jansen et al. (2009); O'Cass et al. (2014); Lin and McDonough III (2011); Lin et al. (2013); Liu and Leitner (2012); Martini et al. (2015); Sok and O'Cass (2015); UN (2007); Voss and Voss (2013); Wang and Jiang (2009); Wang and Rafiq (2014); Yang et al. (2015); Zacher et al. (2016)
Paradox perspective	Andriopoulos and Lewis (2009, 2010); Atuahene-Gima (2005); Knight and Harvey (2015); Papachroni et al. (2015); Saetre and Brun (2012); Wei et al. (2014)

3.4.9 Paradigm Shifts?

Perspectives discussed in previous subsections were further categorised considering some common features them. The dimensions of 'orthogonality versus continuity' (Gupta et al., 2006, p. 693) together with 'static versus dynamic' (Raisch et al., 2009, p. 688) have been adopted as the basis for this categorisation. The former explains whether the perspectives considers the interactions between exploration and exploitation, and the latter looks at if the perspectives involves balancing over time. Taking a continuity perspective would lead to arguments that exploration and exploitation are mutually exclusive, whereas an orthogonal view would be associated with statements that exploration and exploitation interact with each other, and hence, can co-exist (Gupta et al., 2006, p. 695). In addition to 'orthogonality versus continuity', a static perspective implies that the balance needs to be achieved instantly, such as decisions on allocating budget to different projects, whereas a dynamic perspective

would suggest that the balance should be gradually achieved over time (Raisch et al., 2009, p. 688). The inclusion of this framework based on two dimensions allows this review to further compare these perspectives and to determent what has been changing across these perspectives.

According to the categorisation, there appears to be a gradual paradigmatic shift taking place amongst scholars. On the 'static versus dynamic' dimension, temporal ambidexterity made the development by including external factors, such as environment and competition. These are key factors in the conceptualisation from March (1991) into distinguishing between exploration and exploitation. In terms of the dimension 'orthogonality versus continuity', from the classical trade-off to the structural and temporal ambidexterity, those more recent perspectives better consider the inclusion of both exploration and exploitation in organisations. The attention here has shifted from emphasising making choices for either exploration or exploitation towards searching for ways to maintain a balance between these two activities, albeit in very different ways.

Further on this dimension, the contextual ambidexterity has arguably moved beyond the key statements made by March (1991), such as exploitation and exploration will be exclusive to each other and cannot coexist, and attention needs to be paid to the possible interaction between exploration and exploitation. Compared to other perspectives, contextual ambidexterity has moved away from separating exploration and exploitation activities at the level of organisation. However, this perspective may lead to even more confusion about the conceptualisation. Taking the newly emerged paradoxical perspective into consideration, its main argument lies in that organisations could change their mind-sets from either explorative or exploitative towards adapting and accepting the tension innovation may create. This demonstrates a step forward from the 'separation-orientated' view, which requires choices and decisions to be made between exploration and exploitation, towards a more inclusive thinking by considering the nature of these two concepts. Figure 3.2 presents these paradigm shifts

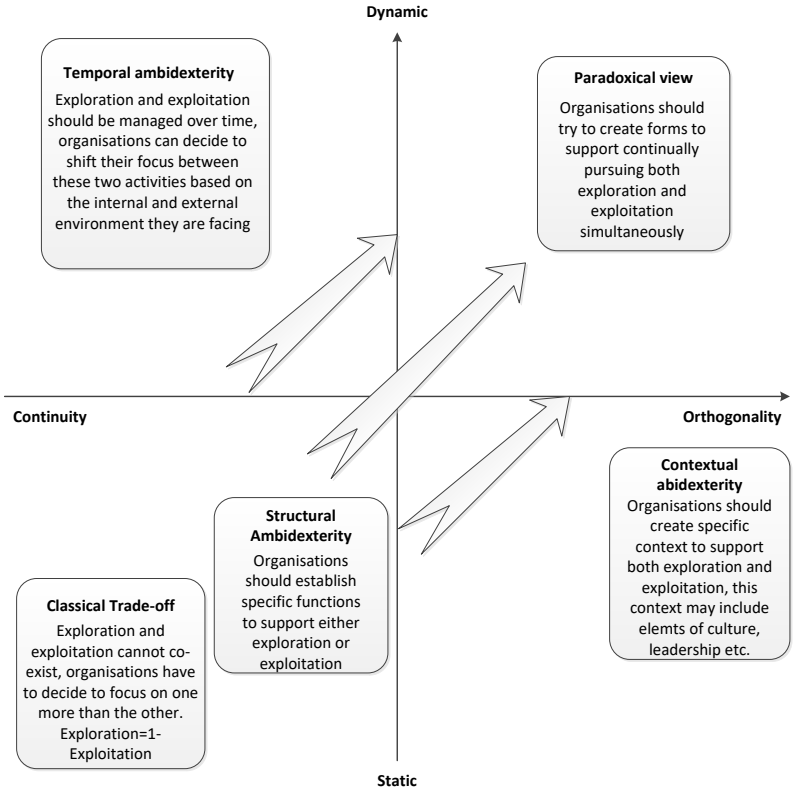


Figure 3.2 Paradigm shift

Noted that the shifts are not a linear process. This means that the emergence of the new paradox perspective has not resulted in the extinction of the older trade-off perspective. Arguably, each perspective still receives support from studies applying it. Nevertheless, it appears that the understanding of the dichotomy has shifted from a classical trade-off perspective, i.e. the original perspective from March (1991), to a more integral paradoxical perspective in the context of innovation management. Referring back to Table 3.5, studies in recent years are still using the classical trade-off perspective and treat it as their foundations for research. However, this paradigm shifting has also signalled further development of perspectives that may reside in moving beyond the paradoxical perspective towards an inseparable perspective.

3.5 Analysis: Theoretical Approaches of Studies

3.5.1 Overview of Theories Used in Previous Studies

As previously discussed (see Subsection 2.2.2), March (1991) drew from four different theories to support his own conceptualisation, which included: rational models of choice, theories of limited rationality, approaches to generic organisational learning and evolutionary models of organisation. Thus, it would be expected that subsequent studies

would likely be referring to similar theories. Table 3.6 presents the papers that included theoretical lenses in their analysis. Note that some of the theoretical lens are related, it is what has been mentioned in a particular study that was recorded. In later subsections, related lenses will be discussed together.

Table 3.6 Theoretical Approaches to Exploration and Exploitation

Theoretical lens	Studies
Evolutionary theories	Benner and Tushman (2003); Clausen et al. (2013); Garcia et al. (2003); Glising and Nooteboom (2006); Hotho and Champion (2010); Jansen et al. (2005); Kim et al. (2010); Lee and Ryu (2002); Quintana-Garcia and Benavides-Velasso (2008); Tushman and O'Reilly III (1996); Yang and Li (2011)
Resource-based view and dynamic capabilities	Benner and Tushman (2003); Garcia et al. (2003); Lin et al. (2013); Martini et al. (2015); O'Reilly and Tushman (2011); Wei et al. (2014); Yalcinkaya et al. (2007); Yang and Li (2011)
Organisational learning	Greve (2007); Hernandez-Espallardo et al. (2011); Jansen et al. (2009); Quintana-Garcia and Benavides-Velasso (2008); Yang and Li (2011), Wang and Rafiq (2014); Yang et al. (2015)
Paradox theory	Andriopoulos and Lewis (2009, 2010); Atuahene-Gima (2005); Hotho and Champion (2010); Knight and Harvey (2015); Papachroni et al. (2015); Smith and Tushman (2005); Sok and O'Cass (2015); Wang and Rafiq (2014)
Generic innovation processes	Hotho and Champion (2010); McNamara and Baden-Fuller (2007); Saetre and Brun (2012)
Absorptive capacity	Bierly at al. (2009); Zhou and Wu (2010)
Bounded rationality	Choi and Phan (2014)
Decision making	Cesaroni et al. (2005)
System theory	Carlisel and McMillan (2006); UN (2007)
Punctuated equilibrium framework	Mudambi and Swift (2011)
Project management	Chandrasekaran et al. (2015)
Path dependency and structuration theory	Nemanich et al. (2007)
Contingency theory	Wang and Jiang (2009)

According to Table 3.6, in total 44 papers used or mentioned different source of theories in their own theoretical conceptualisations. Among these theories, ‘evolutionary theories’ of any kind have been referred eleven times, which aligns with one of the strands that March (1991) used. Studies mentioning evolutionary theories (e.g. Glising and Nooteboom, 2006; Jansen et al., 2005; Yang and Li, 2011) often take fluctuations of the external environment into consideration and argue that the management of exploration and exploitation should be adapted to environmental changes. Since exploration and exploitation were first proposed in

organisational learning, studies have also referred to some generic learning theories (e.g. Greve, 2007; Hernandez-Espallardo et al., 2011; Jansen et al., 2009). Using this strand of theory, studies have mainly been using concepts from learning theories, such as knowledge, to define exploration and exploitation. Similarly, studies building on the dynamic capabilities and the resource-based-view of firms (O'Reilly and Tushman, 2011; Yalcinkaya *et al*., 2007) propose that managing exploration and exploitation is the way for organisations to face a rapidly changing environment. These examples show the influence of theories in conceptualising exploration and exploitation.

The general observation in the theoretical foundation of studies shows that not only the number of studies that include theories is relatively low but also studies are mainly referring to some arguments in other theories. Hence, instead of going deep into theories that studies have referred to, the following subsections will discuss what and how some theoretical arguments have been mentioned and used in the retrieval papers. This is to examine the theoretical foundation of exploration and exploitation among the studies in this review.

3.5.2 Arguments Related to Evolutionary Theory

Management studies have referred to arguments related to evolutionary theory mainly demonstrating the interactions between organisations and their environments in which they operate. Yang and Li (2011, p. 1446) state that because the environment-performance relationships are major factors that affect organisational strategic choices, the decision between exploration and exploitation can be regarded as either reactive or a proactive. Furthermore, these options allow the organisations to respond to contingencies specific to their sectors. This implies that exploration and exploitation are organisational responses to environmental dynamics rather than choice. However, there has not been further elaboration for this argument related to evolutionary theory. Studies have only referred to arguments related to evolutionary theory when applied them in developing research frameworks. For example, Benner and Tushman (2003, p. 244) include the element of ‘adaptation’ to address how organisations use exploration and exploitation in response to changes in the environment.

Arguably, there does not seem to be any serious attempts at using arguments related to evolutionary theory for justifying the conceptualisation of exploration and exploitation. Some studies are mentioning ‘evolutionary theory’ without further discussing the reasoning and logic behind the relationship between this theory and separating exploration and

exploitation. A case in point is the study by Kim et al. (2012, p. 1190), who highlighted key evolutionary economics literature to distinguish between exploration and exploitation. However, they did not further sustain their argument by demonstrating how this distinction works. Overall, studies referring to arguments related to evolutionary theory fail to demonstrate contributions to the conceptualisation of the dichotomy of exploration and exploitation.

3.5.3 Arguments Related to Organisational Learning

For arguments related to organisational learning studies have referred to, it appears that the concept of 'knowledge' has been often used for conceptualising exploration and exploitation. For example, Quintana-Garcia and Benavides-Velasso (2008, p. 493) defined exploration as innovation based on extensive searching for new knowledge and exploitation as innovation based on experimentations using existing knowledge. Other studies use generic learning theories when building their frameworks. Jansen et al. (2009, pp. 6-7) have referred to the 4I (intuiting, interpreting, integrating and institutionalising) framework in learning theory, to further define exploration and exploitation as separated processes. They also studied how leadership styles affect these two processes. Similarly, Yang et al. (2015, pp. 751-753) used steps of knowledge creation, knowledge retention and knowledge transfer to further describe the processes of exploration and exploitation learning in organisation. However, these studies did not further explain the separation between exploration and exploitation, and have arguably taken the dichotomy for granted. Hence, studies referring to learning related arguments did not provide further evidence on conceptualising exploration and exploitation separately.

3.5.4 Arguments Related to Resource-based View and Dynamic Capability

For studies referring to resource-based view and dynamic capabilities, there has been arguments made that depart from the original conceptualisation by March (1991). Wei et al. (2014, p. 835) pointed out to the dynamic resource management view, which describes organisations creating value by constantly structuring, bundling and leveraging resource portfolios; here, balancing exploration and exploitation may be contingent on the capabilities to extend the resource portfolio. Similarly, Yalcinkaya et al. (2007, p. 67) defined exploration and exploitation based on dynamic resources and argued that exploration and exploitation capabilities are closely linked where exploitation provides a foundation for

exploration. This means that exploitation often happens before exploration, because it provides the necessary resources for organisations to explore.

Other discussions mentioning the resource-based view and the conceptualisation of dynamic capabilities seem rather brief. For example, Benner and Tushman (2003, p. 238) stated that dynamic capabilities are anchored in an organisations' ability to both exploit and explore without providing further justification on this point. Overall, although studies referring to the resource-based view and dynamic capabilities provide different takes on conceptualising exploration and exploitation, the dichotomy has still not been questioned.

3.5.5 Arguments from Other Strands of Theories

Besides the arguments from the three relevant theories discussed, there are studies referring to different theoretical arguments that may be interesting to present. UN (2007, p. 11) referred to the design of human resource systems and proposed that an innovatively designed system may provide psychological safety that can facilitate employee to manage both exploration and exploitation. Carlisle and McMillan (2006, p. 4) proposed that viewing from a complex adaptive systems perspective, organisations are able to undertake short-term exploitation activities as required and invest in long-term exploration. Saetre and Brun (2012) have looked at innovation from the view of 'fuzzy-front-end' of new product development and state that ambiguity can be beneficial for this stage of innovation. This may imply that making a clear distinction between exploration and exploitation in innovation processes is less useful. However, their study did not take this logic, instead, their framework still heavily emphasises balancing exploration and exploitation. Overall, although there are some interesting arguments that may lead to challenging the dichotomy of exploration and exploitation, this attempt is not found in these studies.

3.5.6 Paradoxical Thinking: A New Theoretical Approach?

A trend worth noting in the studies is that paradoxical thinking appears to be adopted as an equivalent of a meta-theoretical approach. If the two constructs fit the description of *"contradictory yet interrelated elements (dualities) that exist simultaneously and persist over time; such elements seem logical when considered in isolation, but irrational, inconsistent, and absurd when juxtaposed"*, then they may be considered as a paradox (Smith and Lewis, 2011, p. 387). The relevance to exploration and exploitation lies in the so-called capability-rigidity paradox (e.g. Atuahene-Gima, 2005; Yang and Li, 2011). This paradox is building on the contradiction between making the most of current capabilities

(exploitation) and simultaneously finding new capabilities (exploration). By doing so, organisations boost their innovation capability by finding solutions to this paradox (Atuahene-Gima, 2005, p. 61).

Apparently, studies that refer to paradox theory tend to take on paradoxical perspective (see Subsection 3.4.7). Under this circumstance, studies used the paradoxical view as a way to balance exploration and exploitation towards a new way of thinking what they actually constitute. For example, in the early stage of the development of the paradoxical view, Smith and Tushman (2005) applied it as an alternative way of dealing with the internal tensions between exploration and exploitation. Andriopoulos and Lewis (2009, p. 707) proposed a 'fuelling virtuous cycles of ambidexterity' as a clearer framework of how the paradoxical view can be applied. More recently, Papachroni et al. (2015, p. 87) argued for the need to view exploration and exploitation through a paradox lens as two co-related or co-determinant concepts. As a result, the organisational paradox view has become a different strand of theory that may provide more insight into exploration and exploitation.

3.5.7 Theoretical Evidence

Apart from what is discussed above, other studies have not used any other theories or meta-theories. This means that a large number of studies are using propositions from March (1991) as their theoretical foundation. Also, although other theories have been mentioned, there seem to be no studies that justifying the separation of exploration and exploitation taken from a meta-theoretical perspective. This implies that the theoretical construction of exploration and exploitation is still not valid. Nevertheless, in the papers that allude to meta-theoretical approaches or refer to other theoretical arguments, these are done in a cursory manner. For example, Clausen et al. (2013, p. 226) have mentioned that *"firms are heterogeneous following different approaches to innovation"*. However, they do not elaborate on why or how these approaches arise or how such understanding influences their design of an explanatory framework.

This review found very few studies that actually apply other theories or meta-theories in constructing their theoretical frameworks. For example, in discussing a temporal ambidexterity perspective on exploration and exploitation and how organisation act in different stages, Gilsing and Nooteboom (2006, p. 3) have developed a model for the 'cycle of discovery' that explicitly combines evolutionary theory and institutional theory (ibid., p. 12) of innovation. Broadly speaking, based on the results on examining the use of other

theories or meta-theories, especially linking with the original theories that March (1991) has referred to, doubts were raised regarding the validity of the studies from a theoretical point of view.

3.6 Analysis: Empirical Evidence

3.6.1 Overview of Empirical Studies

Moving from the conceptualisation and theoretical constructions of exploration and exploitation to the empirical evidence, 66 out of 76 papers in this review are empirical studies. 50 of these 66 studies used quantitative approaches, such as surveys (e.g. Brion et al., 2010; Chandrasekaran et al., 2015), quantitative secondary data (e.g. Kim and Huh, 2015) or longitudinal panel data analysis (e.g. Geiger and Makri, 2006). Therefore, studies generally seem to be in favour of quantitative approaches rather than qualitative ones. As for the sixteen qualitative studies, fourteen of these are case studies (e.g. Cantarello et al., 2012; Hotho and Champion, 2010). Gilsing and Nooteboom (2006) tested their model on secondary qualitative data from the Dutch pharmaceutical biotechnology sector and Karhu *et al.* (2016) conducted a series of semi-structured interviews in different organisations.

In terms of the remaining eleven papers that did not include empirical data, two of them have developed a simulation model to support their study (Fauchart and Keilbach 2009; Lee and Ryu 2002), and the remaining six are only conceptual papers that generate theoretical frameworks positioned in other strands of research, such as process management theory (Benner and Tushman, 2002) and paradox theory (Papachroni *et al.*, 2015). Thus, there are plenty empirical studies on exploration and exploitation in the context of innovation management, with the majority being quantitative. It is also expected that quantitative studies and qualitative studies will provide evidence to sustain separating exploration and exploitation from different aspects. Taking these expectations into consideration, the next three subsections will further evaluate the empirical evidence in the context of the quest of this study, and see what evidence has been provided to sustain the dichotomy of exploration and exploitation is.

3.6.2 Evidence from Quantitative Studies

The findings of quantitative studies have mainly provided support for three points. The first point concerns the choice between exploration and exploitation as activities. This often is aligned with the classical trade-off perspective, and the influence of different ways of

managing these activities in practice. For example, Bauer and Leker (2013, p. 207) concluded an inverse U-shaped relation on how firms should allocate resources to either activities and that exploration and exploitation should be pursued simultaneously. Jansen et al. (2009, p. 12) proposed in their study that the mean value of the data they collected shows that organisations prefer exploration above exploitation. Besides the choice between exploration or exploitation, the study from Blindenbach-Driessen and van den Ende (2014, p. 1102) proposed and supported their hypothesis that a separate innovation unit contributes to the implementation of ambidexterity in both service and manufacturing organisations.

Second, the influence of other internal or external factors on exploration and exploitation is examined. Quintana-Garcia and Benavides-Velasso (2008, p. 504) found that technological diversification has a strong positive influence on both exploration and exploitation. However, this influence is stronger on exploration. Chang and Hughes (2012, p. 10) and Chang et al. (2011, p. 1671) have reported findings on the state and influence of exploration and exploitation being different based on the size of the firm. Here, smaller organisations are likely to favour either exploration or exploitation, and larger organisations should have the resources to manage and have both activities simultaneously. Other factors that studies focused on include: organisational slack (Geiger and Makri, 2006; Voss et al., 2008), corporate culture (Matzler et al., 2013), leadership style (Jansen et al., 2008; Lin and McDonough III, 2011; Zacher et al., 2016) and social capital (Li et al., 2014). However, it is considered by this review that the evidence from these studies is rather irrelevant, because it did not provide any support on validating the conceptualisation of exploration and exploitation. Hence, this review will not go into more detail discussing the influence from these factors.

Last, the relationship between different ways of managing exploration and exploitation, and performance is explored. Liu and Leitner (2012, p. 106) demonstrated that on a project level both contextual and temporal ambidexterity are significantly linked to increased project performance. However, the effect from structural ambidexterity is not significant. Similarly, He and Wong (2004, p. 492) claimed that the interactions between exploration and exploitation have a positive impact on organisational sales growth. Therefore, they claimed that ambidexterity has a positive impact on organisational performance. Besides this, few studies have studied and reported that exploration has an inverse u-shape relationship with organisational performance (Kim and Huh, 2015, p. 113; Wei et al., 2014, p. 842). This implies that increasing the level exploration until a certain point will be beneficial to managing innovation.

Thus, it appears that the focus of quantitative studies has mainly been on the outcome of different methods to balance exploration and exploitation. This is commonly linked to firms' performance. However, the quantitative studies analysed in this review only provide limited support in conceptualising exploration and exploitation. This means that the empirical findings from these studies are not quite useful to this review as they fail to sustain the conceptualisation of the dichotomy of exploration and exploitation.

3.6.3 Evidence from Qualitative Studies

In addition, the qualitative studies have lent empirical evidence to three key points. The first point is that studies explained the tensions between exploration and exploitation. According to Andriopoulos and Lewis (2009, p. 701), the tension of practically managing this dichotomy is embedded in strategic intention (profit emphasis versus breakthrough emphasis), customer orientation (tight coupling versus loose coupling) and personal drivers (discipline versus passion) in managerial activities, by when they undertake a comparative case study with five cases that they categorised as 'ambidexterity'. Knight and Harvey (2015, pp. 817-819) suggested that the tension in innovation exists in three dimensions of knowledge, learning and motivation, whereas Cantarello et al. (2012, pp. 38-39) identified tensions based on views on technology and market. Having identified these tensions, these studies also proposed how managers should respond to these tensions. However, it seems that although these tensions have been discovered in their case studies, there is a lack of evidence to link the reason of this tension to exploration and exploitation. Hence, this review further argues that these empirical findings only supported that there is tension in managing innovation and provided little support in validating the dichotomy of exploration and exploitation.

Second, some of the studies describe how managers perceive exploration and exploitation in practice. For example, Cantarello et al. (2012) described how managers should not only consider exploration and exploitation when thinking about innovation or product development processes, but they must also consider it when thinking about marketing and strategy building. Coradi et al. (2015, p. 67) reported exploration and exploitation as two separate learning approaches, where exploitative learning is shown as *"rapid learning with fast feedback loops. It increases efficiency with contacts, improved face-to face communication, more precise and more reliable knowledge as well as better team coordination"*, whereas explorative learning involves *"being curios about the work of others and growing awareness of expertise across functions, more open-mindedness and variable*

knowledge exchange, less formal behaviour in a highly dynamic environment and facilitation of communication and group innovation". However, the evidence on what is considered exploration and exploitation in innovation management is inconsistent within the sixteen qualitative studies. Studies are identifying exploration and exploitation according to the research focus of their studies, there is lack of investigation in whether exploration and exploitation actually exist in practice.

Last, studies have highlighted different situations on how ambidexterity can or should be achieved. For example, Wang and Jiang (2009) demonstrated that the development of teams in companies that can manage exploration and exploitation simultaneously and become ambidextrous. O'Reilly and Tushman (2011, pp. 11-14) investigated fifteen companies and proposed six key features of ambidextrous organisations; these include strategic intent that intellectually justifies the form of ambidexterity, vision and value, ambidextrous strategy, separate units with aligned architectures and ambidextrous leadership. However, a common shortage in the current case studies is that they do not provide a clear indication of what can be considered ambidextrous organisations. This is because case studies using the concept of ambidexterity have not specified the reason or criteria for case selection in their study. Thus, the relevance of these cases to ambidexterity is questionable; in addition to the two studies mentioned in this paragraph, this includes also Cantarello et al. (2012), Durisin and Todorova (2012), Hotho & Champion (2010), Kodam and Shibata (2014), and Liu and Leitner (2012). As a result, questions may be placed to how to define an organisation as ambidextrous; furthermore, there is no evidence sustaining the usefulness of identifying organisations as being ambidextrous.

3.6.4 Direct Evidence on Exploration and Exploitation?

Taking a closer look at the research design of empirical studies, it is noted that some theoretical frameworks are lacking a link between exploration and exploitation with no hypothesis set to test the relationship between these two concepts; examples can be found in the models of Auh and Menguc (2005, p. 1654) and Clausen et al., (2013, p. 229). There are also studies touching on the combined effect of both exploration and exploitation, which has a significant influence on performance (e.g. He and Wong, 2004). However, these studies fail to provide a clear framework to explain how this combined effect could work. In addition to the lack of attention on the relationship, the limited empirical evidence that discerns exploration and exploitation only leads to incompatible conclusions. Chang and Hughes (2012, p. 8) mentioned that with a confirmatory factor analysis of their variables, exploration

innovation is distinctive from exploitation innovation. Furthermore, Hernandez-Espallardo et al. (2011, p. 210) argue that their results can confirm a trade-off between the two types of innovation. However, exploration and exploitation are conceptualised separately in these two studies in the first place; thus, these statements may be self-evident.

In contrast, Greve (2007, pp. 967-968) has found that exploitation innovation and exploration innovation are generated both by similar processes within organisations. However, exploitation here does not affect exploration rates, thus implicitly refuting the trade-off. Furthermore, Blindenbach-Driessen and van de Ende (2014, p. 1102) confirmed that there is a strong correlation between explorative and exploitative activities, and these activities can enhance each other. They further proposed that a separate organisational unit for exploration is beneficial. Consequently, it is still unclear whether exploration and exploitation are notionally separable in innovation management due to the lack of reconciling empirical evidence and absence of adequate research designs that support this dichotomy.

3.7 Discussion of Findings from Literature Review

3.7.1 Summary of Results

The proceeding discussion about the underpinnings of separating exploration and exploitation brings this systematic literature review to some remarks on its review questions. In general, the retrieved papers show that the studies on exploration and exploitation have mainly focused on the need to balance the two and methods for managing the tensions between them rather than validating the conceptualisation of this dichotomy. Examples of positioning the dichotomy can be found in terms of innovation strategy (e.g. Fauchart and Keilbach, 2009), types of innovation (Greve, 2007) and competences (e.g. Yang and Li, 2011).

Most papers referred to the work of March (1991), building on his definition or rather the broad conceptualisation that he proposed. Using his work, some studies have included other concepts as moderating factors. These factors relating to external environment, such as competition intensity (e.g. Garcia et al., 2003) and environmental dynamics (e.g. Geiger and Makri, 2006), are drawing much more attention than others. This is to be expected, because in the second model of March (1991), the state of the external environment plays an important role in the choice between exploration and exploitation. Research into

organisational performance has also drawn attention to the need to manage exploration and exploitation. This has been the main focus of empirical studies (e.g. He and Wong, 2004). Table 3.7 provides an overview of findings from the literature review. These findings will be further elaborated to see how they contribute to the understanding of the four review questions.

Table 3.7 Summary of Findings in Literature Review

Findings	Discussion in Thesis
Five different ways of defining exploration and exploitation	Subsections 3.3.2 and 3.7.2
Definitions of exploration and exploitation are different based on different management disciplines	Subsection 2.3.2 and Appendix I
Relationship between the dichotomy of exploration and exploitation the distinction between radical and incremental innovation not clear	Subsection 3.7.2
Five major perspectives, none of them challenges the separation of exploration and exploitation	Section 3.4 and Subsection 3.7.3
No direct theoretical evidence sustaining exploration and exploitation	Section 3.6.4 and Subsection 3.7.4
Lack of reflection from meta-theories	Section 3.6 and Subsection 3.7.4
Quantitative studies dominating, limited qualitative studies	Section 3.6 and Subsection 3.7.5
Lack of direct empirical evidence supporting exploration and exploitation	Subsections 3.6.4 and 3.7.5
Exploration and exploitation in practice remains unclear with more attention paid to their influence on performance	Sections 2.3 and 3.7

3.7.2 Discussion on Review Question 1

The first question this review followed is: *"for what purpose, both research and practice, has this dichotomy been used in the context of innovation management?"* Since the work from March (1991), studies have been using the concepts of exploration and exploitation as a typology in differentiating or defining managerial practices in the context of innovation management. This typology has been applied in five different ways: 1) as activities related to innovation, 2) as types of innovation, i.e. explorative innovation and exploitative innovation, 3) as organisational competence or capability that enables innovation processes, 4) as strategic goal or firm orientation that guides innovation, and 5) as types of learning that underpin innovation (see Subsection 3.3.2). However, due to the different foci, studies have not reached an agreement on what can be defined as exploration and exploitation. Yet, this dichotomy appears to be applied inconsistently in innovation management.

One topic where these inconsistencies is apparent concerns the relationship between exploration and exploitation, and radical and incremental innovation. Due to differing definitions of exploration and exploitation across the retrieved studies, there are different views on the relationship between these two sets of concepts. Taking exploration and exploitation as types of innovation, Greve (2007, p. 947) argued that radical and incremental innovation are defined based on the industry as a whole, whereas exploration and exploitation innovation is associated with the knowledge that is held by a firm. Also supporting the distinction between the two sets of concepts, Jansen et al. (2008, p. 983) have pointed out that exploration and exploitation have a wider scope than radical and incremental innovation, by considering marketing and customer aspects more explicitly. In contrast, Kim and Huh (2015, p. 108) defined exploration as a special type of radical innovation and exploitation as instance of incremental innovation depending on how new knowledge differs from knowledge already held by an organisation. In this sense, exploration refers to the type of innovation that is developed based on the knowledge that is new to the organisation, whereas exploitation describes innovations that are based on existing knowledge of an organisation. Taking exploration and exploitation as organisational activities, studies have stated that exploration activities that will lead to radical innovation, whereas exploitation will lead to incremental innovation (e.g. Visser and Feams, 2015, p. 362). However, Atuahene-Gima (2005, p. 62) further argues that exploitation will also contribute to radical innovation and exploration to incremental innovation. It seems that what actually constitutes the relationship between exploration and exploitation, and radical and incremental innovation still needs clarification.

This inconsistency has led to the question of what can, is or should be defined as exploration and exploitation in managerial practice. It seems that no matter how the notion is used, studies tend to apply the outcome of an activity or a process for defining whether it is exploration or exploitation. This has raised further doubts whether in practices, it is possible to pre-define an activity or an innovation process in organisations before it actually takes place. This doubt requires further justification of how to define exploration and exploitation by scholars in terms of innovation management in order to be prescriptive or predictive for innovation processes. Therefore, resolving this confusion should be considered as one of the main tasks of the later part of this study (see Section 4.3).

3.7.3 Discussion on Review Question 2

The second review question investigated in this review reads: "*what are the main perspectives of exploration and exploitation in studies of innovation management, and do any of these perspectives challenge the separation of these concepts?*" Viewing from the results, the five perspectives based on the relationship between the concepts and the temporal dimension provides a further development of the notion (see Figure 3.2 for the positions of each perspective). Although there are attempts to refine the original notion from March (1991), it is notable that almost all papers in this study did not provide any challenges to the separation of exploration and exploitation in the context of innovation management. But even then, both the static and dynamic state for the exclusion relationship between exploration and exploitation is based on the acceptance of the key statement by March (1991) that exploration and exploitation will compete for scarce resources, and, thus, are separated processes or activities within an organisation (see Subsection 3.3.4). Therefore, for perspectives, such as structural ambidexterity (e.g. Tushman and O'Reilly, 1996), classic trade-off with resource and budget allocation (e.g. Geiger and Makri, 2006), and temporal ambidexterity (e.g. Carlisle and McMillan, 2006), the premise is that significant tension created by the different requirements for exploration and exploitation makes it difficult for these activities to co-exist (see Subsection 3.4.8). Consequently, it is clear that none of the perspectives based on the continuity point of view have challenged the separation of exploration and exploitation.

In terms of the orthogonality point of view, exploration and exploitation interact. Perspectives under this premise express the understanding that exploitation and exploration are not two totally separated processes that exclude each other. In a static state, exploration and exploitation can be happening at the same time without inconsistency or conflict if there is a suitable organisational context (Gibson and Birkinshaw, 2004, p. 211). In the dynamic view, exploration and exploitation can build on and promote each other on the long run (Andriopoulos and Lewis 2009, p. 707). Although based on simulation instead of empirical data, Garcia et al. (2003) have further argued that exploitation is path-dependent on exploration, which demonstrates the strong link between the concepts. However, studies based on this 'interaction' view did not take the discussion further and do not provide a full justification of the notion, and as a result, are still relying on the original dichotomy made by March (1991) that treats exploration and exploitation as separated activities or processes within an organisation.

As a result, although there have been some developments shown in perspectives proposed after March (1991), none of these perspectives contains challenges to the conceptualisation of the dichotomy of exploration and exploitation. These results are also linked an implicit proposition that how organisations will know if they have reached ambidexterity. However, because ambidexterity is defined as organisations capable of manage both exploration and exploitation, it is impossible to know whether an organisation is ambidextrous until the outcomes of exploration and exploitation are known. Also, even with the possibility to see organisations creating separate units to achieve structural ambidexterity or changing management styles to achieve contextual ambidexterity, these actions does not necessarily mean that these organisations are becoming ambidextrous. Hence, it may well be that being ambidextrous may not have any impact on how organisations compete and perform in terms of innovation; see Subsection 4.4.4 for how this study views ambidexterity.

3.7.4 Discussion on Review Question 3

The third review question analysed in this review is "*in the theoretical construction and use of this dichotomy, has there been any attempt to articulate meta-theoretical presuppositions or referred to other theories?*" Surprisingly, in this review, the number of studies that have referred to meta-theoretical concerns or using other theories in justification is lower than expected. In addition, from the 44 studies that have referred to other theories and intimated meta-theoretical concerns, the majority has just made a simple statement without further reasoning. However, it appears that the use of the paradox perspective as a new conceptual lens for analysis has provided new insight on the notion and stimulated the emergence of questions regarding the original dichotomy (see Subsection 3.4.7 and Subsection 3.5.6). Nevertheless, this review argues that studies building on paradoxical thinking do fail to take a step back by examining directly the dichotomy made by March (1991) and considering whether it is the assumptions that exploration and exploitation are separable that has turned this dichotomy into a set of paradoxical concepts in the first place; see Subsection 4.4.2 for further elaboration.

It was the original intention of setting this third review question to see if studies following March (1991) have provided a full justification of the notion from perspectives of meta-theory. However, the outcomes appear surprising (see Subsection 3.6.4). The possible reasons behind this finding may be that the focus of papers in this review has moved beyond exploration and exploitation itself towards more practical aspects, such as achieving ambidexterity. In this sense, the original dichotomy proposed by March (1991) has been

applied as a partial 'meta-theory' by these studies, relying on the key statements he made; see the influence of these key statements in Subsection 3.3.4. Hence, there is no further theoretical validation found in sustaining the dichotomy of exploration and exploitation. This implies that the dichotomy itself may be a Gettier problem (see Subsection 2.4.2). Consequently, it is arguable that these studies have taken the notional separation of exploration and exploitation for granted rather than examining it before adopting it in their own research design; see Subsection 4.2.2 for further discussion on this point.

3.7.5 Discussion on Review Question 4

The fourth review question is presented as *"Empirically, what is the evidence base to sustain the notional separation of exploration and exploitation?"* It seems that even though the notion has been drawing ample attention from researchers into innovation management, there are no studies that have directly examined the relationship between exploration and exploitation. This might be due to the fact that studies tend to focus on the relationship between the notion and organisational performance (see Subsection 3.6.2). Also, with survey-based quantitative studies dominating, the number of explorative studies into the dichotomy itself is limited. As stated previously in the Subsection 3.6.2, the correlation between exploration and exploitation is under-researched in quantitative studies.

Even with studies that have tested this correlation, it still seems problematic, because this has been done only as a way to validate exploration and exploitation as variables. It is obvious that if exploration and exploitation are measured by different set of items that are often contradicting, the likelihood that these two variables are not correlated or negatively related is high; see Subsection 5.2.2 for a summary of measurements. Hence, these tests cannot be considered as evidence for validating the separation of exploration and exploitation. With regard to qualitative studies, the focus has been on finding the 'best practice' rather than exploring how exploration and exploitation are actually being used. Also, the studies tend to fit data they collect into pre-settled categories (i.e. separated exploration and exploitation) rather than trying to describe how organisations operate. These limitations in current empirical evidence should be taken into account for the research design of this study for a better understanding of exploration and exploitation; see Subsection 5.2.3 for more discussions about the limitations in current empirical evidence.

3.8 Summary of Chapter 3

This chapter presented a systematic literature review focusing on the justification and the empirical evidence sustaining the dichotomy of exploration and exploitation in the context of innovation management. Based on systematic approaches on searching, selecting and analysing relevant papers, it provided an in-depth review on studies about exploration and exploitation in innovation management. Some key points discussed in this chapter are as follows:

- The systematic approaches to literature review used by this is shown through the aspects of (1) four pre-set review questions, (2) detailed search strategies for retrieving relevant papers and (3) exclusion criteria for finalising the lists of paper for detailed analysis, and (4) a spreadsheet to record results and findings about the papers
- The influence from the seminal paper of March (1991) is discussed, this includes how has current studies cited the work of March (1991), development based on its definition, conceptual models and key statements, and the perspective of 'classic trade-off'.
- Introducing the concept of ambidexterity into the discussion, the perspectives of temporal ambidexterity, structural ambidexterity and conceptual ambidexterity can be found in current studies. Besides these ambidexterity-based approaches, recent studies have also arguing that paradox perspectives may be a way forward in understanding exploration and exploitation.
- Regarding theoretical evidence in studies that have referred to meta-theories or other theories, arguments referring to theories such as evolutionary theory, organisational learning theory, resource-based view and dynamic capability are commonly mentioned. Besides, general paradoxical thinking has also been used as a theoretical foundation for the notional separation of exploration and exploitation.
- As for empirical evidence, the majority of the studies in the analysis is quantitative, and the focal points of these studies have been on the performance implication of the dichotomy instead of directly on exploration and exploitation. Similarly, there is limited evidence on what is exploration and exploitation in qualitative studies.
- The results of this literature review have not been able to find evidence sustaining the dichotomy of exploration and exploitation.
- The lack of both theoretical and empirical evidence suggested problems regarding the dichotomy, which will be looked at by this study.

The outcome of this review has shown that there are problems on validity of the dichotomy in current studies and strengthen the outcomes of the scoping study presented in Chapter 2. This has also provided support for the formulation of the research problem in this study.

Chapter 4 Problem Statement and Conceptualisation

4.1 Introduction

The aim of this chapter is to formulate research 'problems' to be focused on for the empirical study. This task will lead to the revisiting the research aim and putting forward research questions of this study. This chapter also include the developed research frameworks to guide the later empirical study. Accordingly, Section 4.2 will describe the research problem that is of interest. Section 4.3 will then indicate the research aim and research questions of this study, before this chapter ends with developing and demonstrating two research frameworks for the empirical part of this study.

4.2 'Problems' of Interest

In Section 2.4, viewpoints of 'distinguishing between postulation and domain assumptions' (see Subsection 2.4.1), 'meta-theoretical reflection' (see Subsection 2.4.2), and 'problematisation method' (see Subsection 2.4.3) have been put forward as possible ways to justify the novelty research agenda of this study. In Chapter 3, current literature related to exploration and exploitation in innovation management was reviewed to understand what has been done, what are the outcomes and what aspects still needing further study. This review also looked at whether the viewpoints discussed in Section 2.4 have been used in current studies. Therefore, based on the outcomes of the literature review discussed in Section 3.7, this section will discuss how these outcomes link to the problem of interest in this study and whether the viewpoints presented in Section 2.4 can be applied in studying exploration and exploitation. By doing so, the aim of this section is to justify the research problem that this doctoral study pays attention to and further specify it into two main arguments of this thesis.

4.2.1 Gaps in Current Literature

Findings from the literature review suggested that previous studies on exploration and exploitation have taken the conceptualisation of exploration and exploitation as it is and without providing sufficient justification for this dichotomy (see Subsection 3.7.1). Table 4.1 presents gaps in the current literature that are discovered by this study based on the findings from its literature review.

Table 4.1 Gaps in Current Literature

Findings	Gaps
Five different ways of defining exploration and exploitation	Conceptualisation of the dichotomy on exploration and exploitation is not clear
Definitions of exploration and exploitation are different based on different management disciplines	
Relationship between the dichotomy of exploration and exploitation the distinction between radical and incremental innovation not clear	
None of **the five major perspectives** challenges the separation of exploration and exploitation	The dichotomy of exploration and exploitation is not challenged in current studies
No direct theoretical evidence sustaining exploration and exploitation	
Lack of reflection from meta-theories	
Quantitative studies dominating, limited qualitative studies	There is no empirical evidence sustaining the use of this dichotomy in practices
Lack of direct empirical evidence supporting exploration and exploitation	
Exploration and exploitation in practice remains unclear with more attention paid to their influence on performance	

These gaps in Table 4.1form are the foundation for the problem of interest in this study. The logic is as follows. Subsequent studies, in which exploration and exploitation were explicitly formulated, mainly built on the original conceptualisation of March (1991) and did not verify it. This point can be supported by the fact that current perspectives did not provide challenges to the dichotomy itself (see Section 3.4). This has led to the point that there is a lack of both direct theoretical and empirical evidence justifying the concepts. This lack of justification resulted in the third point that the separation of exploration and exploitation has not been challenged in current studies. The absence of challenges to the dichotomy itself is the problem of interest in this study.

As a result, there is need for further investigation into the use of exploration and exploitation by challenging this dichotomy. This includes validating the conceptualisation of the two concepts and finding direct empirical evidence. However, it is necessary to know what ‘challenge the separation of exploration and exploitation’ actually means and why is this ‘problem’ worth the research interests; the following subsections therefore will link this ‘problem’ to the viewpoints presented in Section 2.4.

4.2.2 View Exploration and Exploitation as Assumptions

The phrase ‘challenging the separation (or dichotomy) of exploration and exploitation was mentioned a few times in this thesis. For a better understanding of the theoretical rigour for this phrase, this subsection explains why and how the dichotomy of exploration and

exploitation is viewed as an assumption. To start with, the contention of the challenge is that if exploration and exploitation as opposing constructs (this statement is formulated sometimes as 'separation of exploration and exploitation' in this thesis) are not adequately supported by empirical data, it could be considered an assumed dichotomy, albeit a convenient one, rather than a material fact.

Based on this understanding, this dichotomy can be further evaluated based on different types of assumptions. Referring back to Subsection 2.4.1 for different types of assumptions, postulations are defined as assumptions that are explicitly formulated and background assumptions as assumptions that are not expressly formulated but embedded in postulations. In terms of exploration and exploitation, it is the work of March (1991) in which the dichotomy of exploration and exploitation is explicitly formulated (see Subsection 2.2.2). The key statements made by March (ibid.) in Subsection 3.3.4 can therefore be considered postulations. The background assumption that underpins these postulations can be formulated as that exploration and exploitation are two clearly differentiated constructs. This means that (1) exploration and exploitation can be clearly and consistently defined as two theoretical constructs and (2) exploration and exploitation can be observed as two distinct practices. The second point here can be further elaborated as a person or a team is solely doing either exploration or exploitation at a given point of time.

Narrowing this background assumption down to the domain of management studies and specific to innovation management disciplines, the domain assumption behind exploration and exploitation is then being these two are separated (no matter taken what types of definition such as activities or processes) in organisations and should be managed differently in innovation processes or systems. This is to say that 'pure' exploration and exploitation can be defined and observed in managing innovation. This implies also that resources for exploration and exploitation are not shared, and there should be situations in which there are no overlaps between the two. With these distinctions underpinned by different types of assumptions, it is then worth to see how valid the postulations, background assumptions and domain assumptions of exploration and exploitation are.

In fact, some of the postulations made by March (1991) have already been discussed and challenged in other studies (being called key statements in Subsection 3.3.4). Subsection 3.7.3 shows that the proposition of contextual ambidexterity and the paradox perspective have challenged the postulation that organisations have to make a choice between exploration and exploitation. Another example is that Gupta et al. (2006, pp. 695-696)

challenged the postulation that exploration and exploitation will compete for scarce organisational resources by re-examining the nature of such resources and argued some of the resources in organisations are not scarce (see Subsection 3.4.2). Besides these challenges, studies have also provided evidence for some of these postulations (see theoretical evidence in Subsection 3.5 and empirical evidence in Subsection 3.6).

However, linking back to the viewpoint of 'justified true belief' (Subsection 2.4.1), all evidence is arguably not strong enough to validate the dichotomy. Arguments from other studies only corroborate the justified true belief concept for exploration and exploitation with points, such as: exploration and exploitation lead to different innovation outcomes and organisational performance (e.g. Wei et al., 2014), organisations engaged in both exploration and exploitation will experience positive performance (e.g. He and Wong, 2004), organisations can build different unions between subgroups to support either exploration and exploitation (e.g. O 'Reilly and Tushman, 2004). Hence, to have a fully justified dichotomy, there is a need for more direct empirical evidence, theoretical logic and causal reasoning. For theoretical validation, only looking at the level of postulations may not be sufficient and further examination of the background and domain assumptions is necessary with reference to meta-theoretical reflections (see Subsections 2.4.1 and 2.4.2).

The background assumption that exploration and exploitation are separated constructs seems reasonable, because the distinction between the terms 'exploration' and 'exploitation' can be made when used in other circumstances. For example, in oil drilling, exploration refers to a search for new potential mines, whereas exploitation refers to extracting oil from a current mine. Under this context, new mines and current mines are distinguished clearly, hence, discussing exploration and exploitation separately appears valid. However, framing this distinction to the management domain may appear less reasonable. First, it may be more difficult to make a distinction between exploration and exploitation in managerial practices. Referring back to Subsection 2.3.2, March (2006) hints that 'pure' exploration or exploitation may not be possible to define in organisational activities or processes. If this is the case, then the domain assumption of separating exploration and exploitation in management may not make any sense. Second, the phenomenon that exploration and exploitation are constructed has also been covered by other concepts that are defined with more clarity. A case is the distinction between alignment and adaptability. Here, alignment means *"coherence among all the patterns of activities in the business units"*, whereas adaptability refers to *"capacity to reconfigure activities in the business quickly to meet changing demands in the task environment"* (Gibson and Birkinshaw, 2004, p. 209).

Compared to exploration and exploitation, alignment and adaptability focused on implementing change in organisations, and is defined clearly as behavioural capability. However, in the case of exploration and exploitation, the definitions of these concepts are still unclear (see Subsection3.3.2). This means that logically, using the dichotomy in the context of management may be questionable.

In addition to the problems for separating exploration and exploitation in management studies, from a meta-theoretical point of view, alternative arguments do exist derived from generic innovation models or evolutionary related theories (see Subsection 2.2.2). Consequently, it may be fair to say that although the background assumption of the dichotomy of exploration and exploitation is reasonable, when it is applied to innovation management, the domain assumption becomes challengeable.

4.2.3 Moving Forward with Two Arguments

As the literature review previously suggested, current definitions on exploration and exploitation are commonly based on outcomes of certain activities or processes. Linking back to the discussion in Subsection 3.7.2, in managerial practices, it may be impossible to use exploration and exploitation to define ongoing activities or processes. Together with the discussion on why the domain assumption of exploration and exploitation is not reasonable, these discussions have led to the first argument that this study wants to make as:

Argument 1: If exploration and exploitation can only be defined based on outcomes of activities or processes, then the dichotomy is only helpful in evaluating past performance, whereas not being used in managing future innovation because it has no impact on managers' on-going decision making.

In other words, managers will not know if they are making decisions related to the dichotomy of exploration exploitation until the outcome of this decision is revealed. This implies that at any point of time before the outcome is clear, it is impossible to observe a person or a team solely doing either exploration or exploitation, which goes against the background assumption of this dichotomy. Exploration and exploitation may be useful for evaluating previous innovation performances of organisations that have already reached certain outcomes. To verify this argument, this study will first clarify the use of exploration and exploitation as criteria of evaluating innovation outcomes, then further investigate how

decisions are made in managing innovation, and last, explore whether exploration and exploitation actually has any impact on decision-making.

In addition to the first argument, the recent development in current studies have paid attention to the so-called 'interaction' of exploration and exploitation, which has led to the proposition of the second argument of this study as:

Argument 2: The dichotomy of exploration and exploitation are not very helpful in aiding managerial practices.

The logic behind this argument is that if the 'interaction' between exploration and exploitation is so important, it may as well be the case that there is no such thing as 'pure exploration' or 'pure exploitation'. Therefore, it may be impossible to categorise a certain activity as exploration or exploitation. This clearly goes against the domain assumption of this dichotomy. Hence, exploration and exploitation cannot be defined or occur without each other. Consequently, if nothing can be defined as exploration or exploitation, the conceptualisation of the dichotomy between the two is not helpful for neither theories nor practices. Therefore, further empirical investigations are needed to determine whether it is possible to define 'pure exploration' or 'pure exploitation' in innovation management.

The current state of empirical research has to some extent strengthened Arguments 1 and 2. First, it is still not clear whether in practice exploration, exploitation and ambidexterity are relevant to managing innovation and relatable decision-making, supporting Argument 1. Second, previous studies fail to clearly demonstrate how the conceptualisation of exploration and exploitation is reflected in practice, supporting Argument 2. To sum up, from a theoretical standpoint, the dichotomy of exploration and exploitation is problematic. Additionally, from an empirical point of view, there is lack of evidence to support this separation. To validate the domain assumption underlying this dichotomy in innovation management, this study formulated two arguments that need to be verified. These two arguments are the reason for conducting this research and will guide the design of the subsequent empirical study.

4.3 Research Aim and Questions

The previous section has pointed out a 'problem' in current studies into exploration and exploitation that is of the interest in this doctoral study. To tackle this 'problem', and also

the research objectives mentioned in Subsection 1.4.1, the aim of this doctoral study is to validate the notion of exploration and exploitation in the context of innovation management to provide insight into how innovation may be better understood and managed. This will be accomplished by challenging the dichotomy of exploration and exploitation and investigating its domain assumption. Based on this aim and taking the two arguments proposed in the previous sections, the research objectives are refined, and research questions are formulated as follows:

Research Question 1: How to identify organisations that manage exploration and exploitation efficiently?

Research Question 2: How does performance in terms of outcomes and resource allocation in the context of ambidexterity influence on-going decision-making on innovation management?

Research Question 3: What are the practical treatments of exploration and exploitation in managing innovation and are they treated separately to the extent assumed by March (1991) in practice?

Research Question 4: How innovation management could be understood if exploration and exploitation are not separated in practice?

4.4 Developing Research Frameworks

To offer some guidelines for addressing the research questions, two research frameworks were developed based on existing theoretical models prior to the research design and the empirical study. The reasons for why two frameworks are needed will be discussed in the first subsection. The following subsections will address how and what frameworks have been developed based on the process of identifying suitable models for this study, evaluating and selecting models, and presenting the model developed. The conceptualisation of exploration and exploitation will also be embedded in the presented frameworks.

4.4.1 Purpose of Research Frameworks

The research frameworks developed in this Chapter are expected to contribute to verifying the two arguments proposed in Subsection 4.2.3. Additionally, based on the research questions stated in Section 4.3, the research frameworks should serve three main purposes

in this study: (1) understanding exploration and exploitation as performance evaluation criteria, and (2) making clear how exploration and exploitation can be defined or observed in managerial practices (i.e. in internal processes of organisations), and (3) investigating their impact on on-going decision making. These three purposes as a result led to two different ways of conceptualising exploration and exploitation. Hence, there is a need for two research frameworks in this study. **Research Framework 1** should reflect exploration and exploitation as criteria for evaluating outcomes. This framework should arguably be able to capture a 'snapshot' of the innovation processes for clarity on performance evaluation. **Research Framework 2** should support exploring exploration and exploitation in practices and make clear their impact on on-going decision making. Hence, a dynamic view is needed, external factors that may have impact on innovation such as completions and markets should also be considered. The next subsections will then demonstrate the process of developing these two frameworks.

4.4.2 Model Selection

The first issue to consider in selecting models to focus on is what type of model should be reviewed. The research aim here is to treat the dichotomy of exploration and exploitation as an assumption and challenge this notional separation. Referring back to Subsection 3.7.3, none of the existing perspectives have considered this separation as problematic in innovation management. Hence, instead of developing the research framework based on existing models in exploration and exploitation, models and theories in innovation management were referred to as the starting point. The reasons are twofold. First, since this study set to test the domain assumption of the dichotomy in the context of innovation management, building frameworks based on models in innovation management provides direct evidence validating the domain assumption. Second, using frameworks based on models in innovation management enables this study to make the contribution to scholarly knowledge in managing innovation (see Subsection 1.4.4).

In understanding theories and models in innovation management, the distinction between different generations of innovation processes proposed by Rothwell (1994) has been regarded as a useful tool. Particularly, the generations of innovation processes are helpful in identifying and categorising different innovation models. Therefore, before the discussion on how this study has evaluate different models, Table 4.2 presents a short overview of different generations of innovation processes with key features of different generations discussed.

Table 4.2 Generations of Innovation Processes

Generations	Description
First-generation	*Linear model, technology-driven, starting with stage of R&D and finishing with commercialisation*
Second-generation	*Linear model, similar to first-generation, difference is on demonstrating market-driven innovation, process starts with market demand rather than research*
Third-generation	*Coupling model, integrating both technology-driven and market-driven innovation.*
Fourth-generation	*Two key features: integrating and parallel development. Supplier involvement in early stages of the innovation processes*
Fifth-generation	*Emerging paradigm. Innovation depends on collaborative efforts such as joint R&D ventures and R&D based strategic alliances*

Source: Rothwell (1994, pp. 7-12)

With different generations of innovation processes presented, this study has selected models from Burgelman and Sayles (1986), Dussauge et al. (1992), ten Haaf et al. (2002), Nickles (2003), Tidd and Bessant (2013) and breakthrough model from Dekkers (2017). In addition to the models in innovation, this study has included the steady-state model described in Dekkers (2017), which focused on generic processes and systems and is relevant to modelling innovation processes and systems. Table 4.3 provides a basic overview of each model selected with descriptions; for details see Appendix I. Further evaluation of these models will be presented in the next subsection.

Table 4.3 Overview of Selected Models

Models	Description	Suitable for
Burgelman and Sayles (1986)	Key steps in the model: Planning (forming strategy), turning invention to innovation (integrating technology push and demand pull, similar to third-generation innovation process), value creation on innovation (including ventures, one product business and multiline business.	Research Framework 1
Dussauge et al. (1992)	Focusing on managing technologies R&D is based on three elements: existing techniques, scientific knowledge and problems to be solved Emphasising on innovation success is based on: leadership, teamwork, managing boundaries and simultaneity	Research Framework 1 & 2
Steady-state Model: Dekkers (2017)	Control of a system can be regarded based on three boundary zones for processes and resources: input boundary zone, output boundary zone and regulatory boundary zone. The model applies to a selected aspect and aims at maintaining a steady state.	Research Framework 1
Breakthrough Model:	First step, scanning the environment and set new or adapted goals.	Research Framework 2

Models	Description	Suitable for
Dekkers (2017)	Second, the process of confrontation and tuning takes the possibilities into account leading to specific decisions on the utilisation of resources and structures for operations. Third, through the configuration and resource allocation process the actual implementation of the structural changes in operations takes place.	
ten Haaf et al. (2002)	Product development model based on 'life cycle' of technical systems Key stages discussed in the model includes researching needs and wishes, developing the product requirement plan, developing the concept design, developing product design, manufacturing, use/maintenance, ending use and renovation.	Research Framework 2
Nickles (2003)	Based on evolutionary models, mainly considers innovation as 'adaptation' Innovation is enabled with a process of blind variation plus selective 'retution'	Research Framework 2
Tidd and Bessant (2013)	Key steps in the model: Search, select (decision-making), implement, capture (value creation, new ventures, learning). Under different types of innovation such as product, processes, position (market segments), paradigm (business model).	Research Framework 1 & 2

4.4.3 Evaluating Suitable Models

To further evaluate the selected models, two criteria were developed for evaluations of **Framework 1** and three criteria for **Framework 2**. As stated in Subsection 4.4.1, Framework 1 aims to examine the use of exploration and exploitation in performance evaluation. Hence, the first criteria for evaluation of models for Framework 1 is that the model should capture a 'snapshot' of the innovation processes in certain time intervals for performance evaluation. Also, because the performance to investigate here concerns the innovation process as a whole, the second criterion has been set that the model should be focused more on innovation processes rather than functions in organisations. Table 4.4 presents the model evaluation for **Research Framework 1**. Based on the table, the steady-state model is selected for developing **Research Framework 1**.

Table 4.4 Model Evaluation for Research Framework 1

Models	Capture a 'snapshot'	Focused on innovation processes
Burgelman and Sayles (1986)	Yes	The emphasis on this model is more on how to create value based on the outcomes of innovation
Dussauge et al. (1987)	Yes	Lack of details in turning technology into successful innovation
Dekkers (2017) Steady-state	Yes	Although it is focused more on general processes, can be applied to innovation
Nickles (2003)	Generic for 'snapshot'	Lack of focus on how organisations can manage the process
Tidd and Bessant (2013)	A 'snapshot' may be difficult because different stages in this model are hard to distinguish	Describe innovation processes generically, focused on value creation of innovation outcomes rather than how these outcomes are generated

For **Research Framework 2**, the research aim for the empirical study is to challenge the use of the dichotomy in practice and searching for theoretical validation for it. Hence, the first criterion set is that in the models, exploration and exploitation should not by definition be separated. This is also helpful in testing **Argument 2** proposed in Subsection 4.2.3. Second, considering the fact that the conceptualisation of exploration and exploitation is likely to have impact on different functions in innovation management, the models should be able to cover multiple organisational functions involved in innovation processes such as production, marketing, R&D etc. This also requires the inclusion of possible external factors that may affect innovation. Table 4.5 presents the model evaluation for **Research Framework 2**. According to Table 4.5, the breakthrough model is selected to develop **Research Framework 2**.

Table 4.5 Model Evaluation for Research Framework 2

Model	No separation in definition	Cover multiple aspects of innovation
Dussauge et al. (1987)	Yes	Focused on technology management, only brief indication of other aspects of innovation
Dekkers (2017) Breakthrough model	Yes	Yes, the model covers activities from setting strategies to 'implementation' of innovation, creating a dynamic view
ten Haaf et al. (2002)	Yes	Focused mainly on product development, limited coverage from of other functions
Nickles (2003)	Yes	Only a generic description without further details
Tidd and Bessant (2013)	Yes	Did not specify in what functions of organisation will each of the steps having the most impact or take place.

4.4.4 Research Framework 1

For better demonstration of the developed framework, this study refers to two approaches in examining systems, namely aggregation strata and the blackbox approach (Dekkers, 2017, pp. 47-54). Aggregation strata when applied to systems often include zooming in and zooming out between different levels in systems. Zooming in reveal more details of the system in terms of elements and relationships, whereas zooming out provides an overview of the environment in which the system operates (ibid., p. 49). The blackbox approach refers to looking at a system or process without considering its internal elements and relationships. Therefore, this allows the examination of systems or process to focus on their behaviour (ibid., p. 52). Linking with aggregation strata, at one level of aggregation, the process can be considered as a blackbox. In the research framework of this study, the blackbox approach helps to clarify the behaviour of organisations for performance evaluation, because it enables the tracing of input and output to certain processes. Besides, aggregation strata can help provide the explanations of the research framework between different aggregation levels. Hence, with the assistance of these approaches, Figure 4.2 presents **Framework 1** for this study.

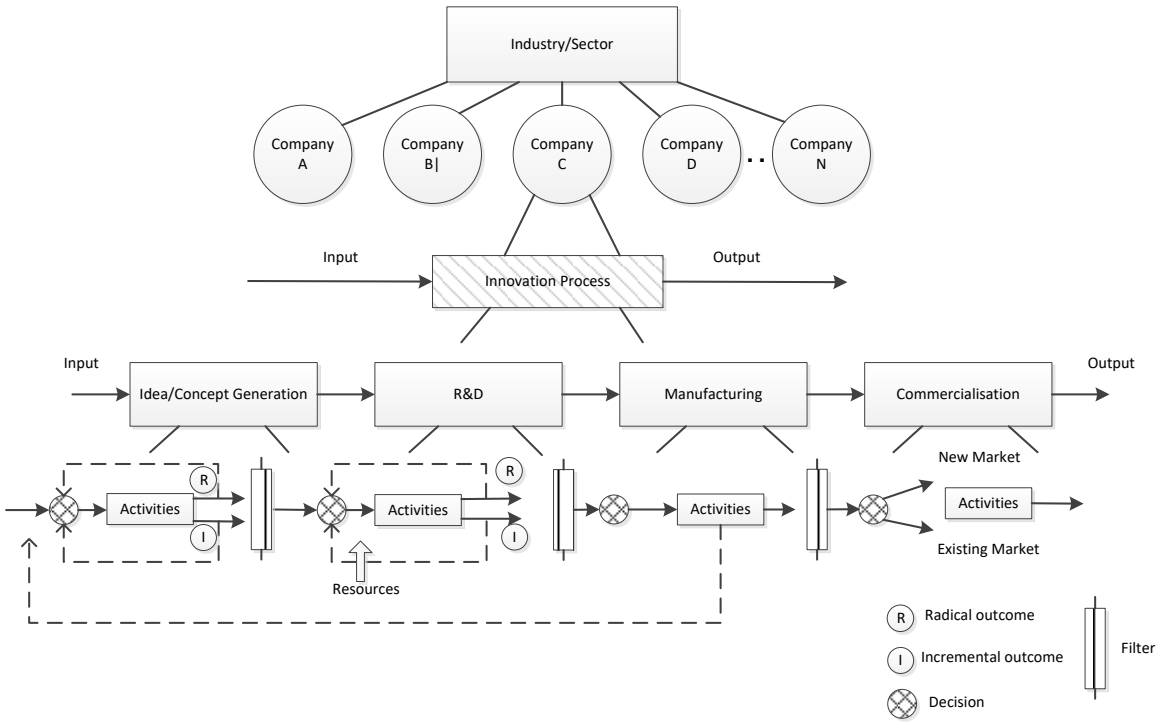


Figure 4.1 Research Framework 1 Based on the Steady State Model)

According to Figure 4.1, as a starting point, organisations are operating within industrial sectors. The reason for the inclusion of this level in **Research Framework 1** is that sector differences have an impact on how well organisations manage innovation processes (Phene

et al., 2006, p. 372). Therefore, the purpose of this part in **Research Framework 1** is to make clear the performance will be evaluated among the organisations within the same sector. Next level of zooming in reveals innovation processes that were presented specifically within each organisation. At this level, these processes are treated as a blackbox. Without looking into the internal processes for each organisation, the performance evaluation relies on the inputs and outputs for these processes. Hence, the conceptualisation of exploration, exploitation and ambidexterity should be based on consideration of both inputs and outputs.

Having discussed performance evaluation, a further zooming in into the innovation processes presents them in a linear manner based on first generation of innovation processes in **Research Framework 1**. The reason for this is to demonstrate the stages included in the process, where inputs to innovation is generating innovation outcomes (see Subsection 2.3.1 for definition). To be more specific, the last part of the model provides an illustration of some more details on these processes based on the steady-state model through zooming in. Note that Research Framework act only as a reference model for the empirical investigation, therefore, it may not necessarily represent how organisations are managing innovation processes. In this illustration, each stage of the innovation processes constitutes of activities, which may differ for each organisation. Therefore, they will not be further specified. Before each activity takes place, there are decision-making points that determine what activities will be conducted, as shown in Figure 4.1.

Additionally, the results of each of these activities may be classified into three scenarios: (1) having both radical and incremental outcomes, (2) having either radical or incremental outcomes, and (3) having no outcomes. Note however, **Research Framework 1** presents only the scenario of having either radical or incremental outcomes for clarification purposes. What remains unknown is whether the result of having either radical or incremental outcomes will impact future decision-making. Notably, this is linked to **Argument 1** (see Subsection 4.2.3). Furthermore, when certain outcomes for each activity are reached, there will be an evaluation, which determines whether this innovation process can proceed (shown in Figure 4.1 in forms of ‘filter’). Consequently, the outcome from activities in previous stages will be used as input for the activities in the next stage. This part of **Research Framework 1** has provided an abstraction of the internal processes of innovation management within an organisation. Hence, it can act as a guide for the conceptualising the dichotomy of exploration and exploitation in innovation processes.

4.4.5 Conceptualisation of Key Concepts

Considering this is one of the first attempts to use both inputs and outputs to evaluate innovation outcomes using exploration and exploitation, the scope has been further narrowed down to the stage of R&D in innovation processes. Exploration, exploitation and ambidexterity will then be conceptualised according to resource allocation and R&D outcomes, in line with **Research Question 2**.

In line with using resource allocation and R&D outcome to conceptualise exploration and exploitation, there are some studies define the two concepts as capabilities (see Subsection 3.3.2). For example, Quintana-Garcia and Benavides-Velasso (2008, p. 495) conceptualised exploration as a firm's ability to undertake 'distance searches' (allocation of resources) and generate radical products (outcomes), whereas exploitation is firm's ability to do 'local searches' and generate incremental products. Similar definitions could be found in innovation capability, for example, Lawson and Samson (2001, p. 384) defined innovation capability as "*the ability to continuously transform knowledge and ideas* (resource allocation) *into new products, processes and systems* (outcomes) *for the benefit of the firm and its stakeholders*". Hence, the conceptualisation of the key concepts based on **Research Framework 1** is not without support.

It is also necessary to clarify the relationship between exploration and exploitation, and radical and incremental innovation (see Subsection 3.7.2). Stepping back from the processes of innovation within organisations, radical and incremental innovation can be considered as innovation outcomes, which can only be determined after the innovation processes. Exploration and exploitation can be considered as the 'ability' of an organisation to achieve radical or incremental innovation outcomes by considering its resource allocation (Lin et al., 2013, p. 262). This is beneficial because it is still unclear how exploration and exploitation are reflected in managerial practices within an organisation. Therefore, this conceptualisation provides a better way to understand ambidexterity without investigating the internal organisational processes.

Moreover, this part of the study will investigate exploration and exploitation based on the R&D stage. The first reason is that the conceptualisation of exploration and exploitation is clearer in the R&D phase. Considering the original conceptualisation from organisational learning, exploration refers to finding knowledge new to the company, whereas exploitation refers to finding improvement on existing knowledge. This is better linked with the purpose

of R&D activities within an organisation. Regarding the second reason, inputs and outputs of the R&D phase is relatively tangible. Arguably, it is hard to determine what the actual input and output are for other aspects of innovation processes, because the boundaries of these stages are not as clear as the R&D phase (this may lead to limitations in **Research Framework 1**, which will be discussed in Subsection 9.5.1). Hence, exploration and exploitation are defined as criteria for evaluating R&D outcomes based on resource allocation.

This has led to another possible concern on explaining the results of using exploration and exploitation as evaluation criteria. Looking at current studies, the 'ambidexterity framework' could be applied. As discussed in Subsection 3.4.3, different modes of organisational ambidexterity have been proposed as means to manage exploration and exploitation (e.g. temporal ambidexterity discussed in Subsection 3.4.4, structural ambidexterity in 3.4.5 and contextual ambidexterity in 3.4.6). Despite the proposition of different ways for achieving ambidexterity, studies have yet come to an agreement on what is the best form to do so. Arguably, different approaches to ambidexterity might become useful under certain circumstance (O'Reilly and Tushman, 2013, p. 13). However, previous studies have not clearly established how an organisation can be identified as ambidextrous, without looking at the internal processes of an organisation.

In previous quantitative studies, ambidexterity is often measured by the knowledge that organisations are able to generate and obtain from learning processes. This knowledge is expected to enable both incremental and radical innovation outcomes. In previous qualitative studies, ambidextrous is referred to when companies have a reputation of being innovative and also maintaining a good financial performance. Table 4.6 provides examples of how previous empirical studies have measured or identified ambidexterity. Notably, common ways of measuring and identifying ambidexterity in previous studies are outcome-based. This is reasonable because without looking into the organisational processes, studies tend to define exploration and exploitation as outcomes of certain activities; Subsection 3.7.2 discussed this matter in detail. Hence, if ambidexterity is conceptualised by exploration and exploitation, the measurement of ambidextrous organisations will likely be outcome-based.

Table 4.6 Previous Identification of Ambidexterity

Study	Research Method	Perspective Taken	Ambidexterity
Knight and Harvey, 2015	Case studies, qualitative	Contextual ambidexterity	(1) Leading company in the industry (2) The company has an explicit mandate for change.
Cantarello et al., 2012	Case studies, qualitative	Multi-level ambidexterity, aligned with contextual ambidexterity	Companies: 1) are taking only technology but also custom knowledge importantly, 2) are highly and consistently profitable and simultaneously receiving awards and top ranking for cutting edge innovation, 3) have developed and managed ambidexterity capability in the search phase of innovation processes.
He and Wong, 2004	Survey, quantitative	Not clearly stated	Ambidexterity: 1) have both high score in exploration and exploitation, 2) have relatively equal emphasis on both exploration and exploitation. Exploration: 1) introduce new generation of products, 2) extend product range, 3) open up new markets, 4) enter new technology fields Exploitation: 1) improve existing product quality, 2) improve production flexibility, 3) reduce production cost, 4) improve yield or reduce material consumption
Jansen et al., 2005	Survey, quantitative	Contextual ambidexterity	Ambidexterity: Exploration × Exploitation Sample items for exploration: 1) experiment with new products and service in our local market, 2) commercialise products and services that are completely new to markets Simplified items for exploitation: 1) frequently refine the provision of existing products and services, 2) regularly implement small adaptations to existing products and services

However, this study argues that outcome-based identification of ambidexterity has the following limitations. First, outcome-based measures will likely be neglecting the impact of input size and scale. Notably, it has long been proven in studies that organisational size will have an influence on organisational innovation (e.g. Damanpour, 1992, Mote et al., 2016). Hence, ignoring the input aspect may cause inaccurate results. Furthermore, the results of outcome-based measure do not provide adequate evidence for benchmarking organisations. Second, it is still in doubt whether certain outcomes are actually the output of exploration and exploitation. This is to say the organisational processes of exploration and exploitation

are contained within a 'blackbox' in **Research Framework 1**. Hence, the outcome measurement chosen may not correctly reflect exploration and exploitation. As a result, it may worth consider identify ambidexterity based on both input and output.

To sum up, based on **Research Framework 1** exploration and exploitation are conceptualised here as evaluation criteria considering resource allocation and R&D outcomes. Here, exploration means the ability of generating R&D outcome that is new to the organisation (radical) and exploitation means the ability of generating R&D outcome that is based on existing knowledge of the organisation (incremental). Furthermore, this study will define ambidexterity as organisations that meet both conditions of 1) meets both exploration and exploitation criteria and 2) able to efficiently transfer resources into R&D outcomes; this will be further specified in Chapter 6 with specific measurements. The next few subsections will then focus on the theoretical foundation for the investigation into the internal processes and systems.

4.4.6 Research Framework 2

Research Framework 2 is based on the breakthrough model (Dekkers, 2017, pp. 255-260). The breakthrough model includes the overall necessary processes for implementing changes to organisations that are also applicable to iterative processes such as product development (ibid.). For this study, this model reflects on dynamic adaptation and is able to capture the dynamics of environment. This also means that because **Research Framework 2** is built based on evolutionary theories for organisations (ibid.), it can provide reflection from meta-theoretical perspectives. Overall, this model includes processes of strategy formation, confrontation and tuning, configuration and resource allocation, operations, verification of master plan, and evaluation of strategy (see Dekkers [2017, pp. 255-260] for a full description). These processes will be elaborated later in this subsection. However, this subsection will not present the original breakthrough model in detail, but rather will focus on discuss the second framework developed based on this model. Figure 4.2 presents this **Research Framework 2**.

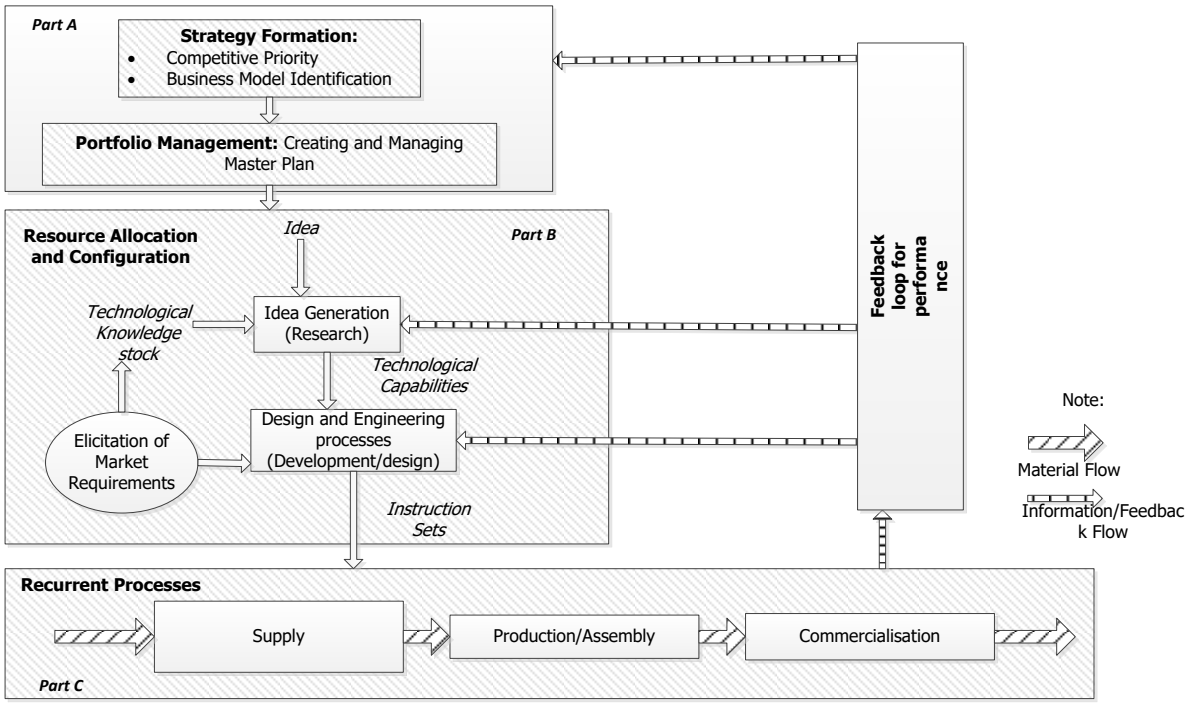


Figure 4.2 Research Framework 2 (Based on Breakthrough Model)

According to Figure 4.2, **Research Framework 2** has mapped innovation processes based on three parts. Part A in the figure considers strategy formation and portfolio management. Generally, the implementation of innovation processes is often based on strategic considerations and its success require a strong influence from organisational strategies (Pohlmann et al., 2005, p. 3; Van de Ven, 1986, p. 605). Therefore, in this framework, strategy formation is included in the first part that consists of competitive priority setting and business model identification. Competitive priority setting refers to strategic decisions made by organisations to focus on certain capabilities, such as cost, quality, flexibility and delivery, which will influence the structure and the infrastructure of operations (Boyer and Lewis, 2002, p. 10). In innovation, emphasising different competitive priorities often serves as a guide for managerial practices and technology development (Peng et al., 2011, p. 485). Taken competitive priorities into consideration, organisations then need to identify suitable business models, because a business model act as an important link between innovation and organisational structure (George and Bock, 2010, p. 88). Here, business model is defined as a description of how an organisation plans to create value in its marketplace (Chesbrough and Rosenbloom, 2002, p. 532). More specifically, business model identification may include the stage of creation, extension, revision and termination (Cavalcante et al., 2011). Competitive priorities and business models are outcome of the strategy formation stage in **Research Framework 2**.

Hence, after strategy formation, organisations also need appropriate portfolio management to support the undertaking of new product development (Cooper et al., 2001, p. 361). Portfolio management often links to project prioritisation, which is about selecting suitable projects and allocating investments accordingly (Cooper et al., 1997, p. 16). Linking to innovation, portfolio management is concerned with decisions on resource allocation that support organisations achieving their new product (or service) objectives (ibid.). This is directly linked with one of the postulations of March (1991) on resource allocation, hence is included in the model. The outcome of the stage of portfolio management can be called a master plan, which considers the feasibility of a course of action based on strategy formation (Dekkers, 2017, p. 257). This master plan also guides downstream processes.

Part B in the figure describes resource allocation and configuration. This part considers the actual realisation of the master plan set during the previous stages (ibid.). Linking it to innovation management, this part of the model reflects on the innovation processes, before the stage of manufacturing (for example, Rothwell, [1994, p. 10]). Two main activities in this part are presented as idea generation, and design and engineering processes. The idea generation presented in this framework can be derived both from research into new technology or from market requirements. Besides, this framework has included the concept of technological knowledge stock as a link between market requirements and idea generation. By definition, technological knowledge stock means *"the cumulative amount of technological knowledge that a firm or an industry possesses at a certain point of time"* (Park and Park, 2006, p. 795). Here, market requirements allow firms to reflect on technology knowledge available, and thus, make decisions on allocating resources to different activities accordingly. However, this process may require further empirical evidence from this study. As a result, the outcome of this part of the model is a set of instructions for manufacturing (this is equivalent to the outcome of manufacturing prototypes in innovation management models). This instruction set should reflect a master plan that is feasible to the organisation.

Part C in the figure illustrates the recurrent processes, which include supplying (of materials), production and commercialisation. This part of the framework is named recurrent processes, because activities, such as purchasing, manufacturing and commercialisation often are embedded in organisational routines. This means that it is unlikely to change dramatically (Feldman and Pentland, 2003).

In addition to the three parts, **Research Framework 2** has included the element of feedback loop for performance because the breakthrough model represents a continuous process, rather than a 'one-time intervention' (Dekkers, 2017, p. 259). It requires feedback and evaluation of different stages for constantly revising strategic decision-making. It may be the case that there will be feedback processes within each stages of innovation, for example, Wooten and Ulrich (2017) have discussed how feedback works for idea generation. Looking at the whole innovation process, there may be feedbacks on performance based on the final outcomes that have influence on early stages of innovation (Gross, 2017). However, because the feedback loop is closely linked to the question of how past performance of exploration and exploitation may have impact on ongoing decision-making, the feedback mechanism in this framework is not specified at this stage. It may be more beneficial to explore how feedback works as part of innovation processes in organisations and considering feedback based on empirical data of this study.

Different from **Research Framework 1**, key concepts such as ambidexterity, exploration and exploitation will not be specifically defined in **Research Framework 2**. This is because that the main purpose of this framework is to guide the empirical investigation into the internal innovation processes in organisations. As part of the objectives, this investigation will explore what does the dichotomy of exploration and exploitation actually means in innovation. Hence, when using this framework, it would be better not to have pre-set definitions for exploration and exploitation; this will be further discussed in Subsection 7.2.1.

4.4.7 Overviews of Two Frameworks Developed

Overall, to suit the focus of this study, two different but linked frameworks have been developed to guide the empirical part of this study in validating the two arguments proposed and searching for answers to the research questions. Here two frameworks will serve different purposes. **Research Framework 1** is more suitable for investigating the use of exploration and exploitation as evaluation criteria and aiming at verifying Argument 1 (see Subsection 4.2.3). **Research Framework 2** provides a more comprehensive view of innovation processes in organisations. It also enables this study to have a meta-theoretical perspective based on evolutionary theory. Therefore, it is applicable to guide the examination of internal processes of organisations and making sense of exploration and exploitation in practice. This helps to support both Argument 1 and 2 (see Subsection 4.2.3).

Linking to assumptions discussed in Subsection 4.2.2, because in **Research Framework 1**, exploration and exploitation are still conceptualised as two distinctive criteria, it does not allow directly challenge to the domain assumption of this dichotomy, but it is a step towards it. **Research Framework 2** provides a direct challenge to the postulations, which will be discussed in Subsection 7.2.1, and the domain assumption by not having pre-set definitions for exploration and exploitation. Instead, based on this framework, whether the dichotomy of exploration and exploitation is actually helpful in managerial practices for innovation management is investigated.

As a result, it is necessary to include both frameworks in the research design and the empirical inquiries in the following chapters. It should be noted that the two frameworks developed in this chapter are based on theoretical interpretations with reference to existing models. Hence, this study requires further empirical data to support and adjust the frameworks in order to make contribution to theories in innovation management.

4.5 Summary of Chapter 4

This chapter formulated the problems of interest for this study, generated its research questions, and presented two research frameworks that will guide the empirical inquiry in the later. As a result, the outcome of this chapter allows the start of research design in the next chapter. Some key points of this chapter are as follows:

- Exploration and exploitation should be considered only as assumptions, and it is the domain assumption that that needed to be challenged.
- Two arguments are proposed to elaborate why this domain assumption should be challenged. **Argument 1** questioned whether exploration and exploitation may influence on-going decision making as part of managerial practice, whereas **Argument 2** indicated the problem in defining exploration and exploitation as separable constructs, which makes the use of this dichotomy in practice impossible.
- **Research Framework 1** based on steady-state model is presented, where exploration and exploitation are conceptualised as R&D capabilities, and ambidexterity is defined accordingly as organisations that are performing well in terms of both capabilities. This framework will be used to examine exploration and exploitation as performance criteria.
- **Research Framework 2** based on breakthrough model that can capture the dynamics of internal organisational processes is demonstrated. This framework will be used to investigate the use of the dichotomy of exploration and exploitation in internal processes of organisations.

Chapter 5 Research Design

5.1 Introduction

The aim of this chapter is to select and detail the appropriate research methods to use in the empirical part of the study. Based on the refined research questions presented in Section 4.3, the research methods identified in this chapter are designed to elicit answers to the four research questions (see Section 4.3). Hence, Section 5.2 will first evaluate the research designs used by previous empirical studies specific to exploration and exploitation. Section 5.3 then discusses the development of a **Process Model** for the research design derived from a generic design model normally used for new product development. In addition, methodological considerations that include research philosophy and approach are shown in this section too. Section 5.4 will detail this **Process Model** and the basic structure of the research design. Here, design structure refers to 'research choice', which considers the likes of qualitative, quantitative or mixed methods. Section 5.5 will focus on the selection for the method on the industrial level of analysis, with the method selected being presented in Section 5.6. Section 5.7 demonstrates the selection of the method for the internal level of analysis with the selected methods detailed in Section 5.8. The chapter will end with Section 5.10 presenting an overview of the whole research design process.

5.2 Evaluating Previous Research Designs

This section evaluates previous research methods used to study the conceptualisation of exploration and exploitation in the context of innovation management. This evaluation includes both the research methods and measurements that were developed and used. The reasons for the inclusion of this evaluation are as follows. First, summarising previous measurements used for exploration and exploitation provides insights for how this study may measure these two constructs. In addition, this helps achieving the objective of effectively examining how exploration and exploitation can be used as performance evaluation criteria for innovation management. Second, this evaluation also allows this study to clarify the limitations in previous research methods and measurements (see also Subsection 3.7.5). Linking these limitations to the empirical outcomes of current publications can help this study to avoid similar drawbacks in the research design. Hence, the following subsections will first provide an overview of previous research methods and measurements of exploration and exploitation used, before demonstrating the limitations of research methods in current studies.

5.2.1 Summary of Previous Research Methods

Starting with a summary of previous research methods in the papers of the systematic literature review in Table 5.1 (see Appendix II for the full list of studies evaluated). According to Table 5.1, it seems that quantitative studies with methods based on regression analysis are the most 'favourable' methods for investigating the dichotomy.

Table 5.1 Previous Research Methods

	Methods	Number of Papers
Quantitative	Regression analysis	31
	Structural equation modelling	7
	Path modelling	6
	Event modelling	3
	Panel negative binomial modelling	1
	Generalised estimating equation	1
	Panel data analysis	1
	Group comparison analysis	2
Qualitative	Case studies	13
	Interviews	1

In addition to the preference for quantitative over qualitative methods, the level of analysis also represents an interesting talking point. The level of analysis refers to the size and scale of the objects in studies (Gully et al., 1995, p. 500). In existing literature, exploration and exploitation will likely have different definitions for different levels of analysis (Lavie et al., 2010, p.142; Li et al., 2008, p. 112). Therefore, to get a more comprehensive view of the discussion, 'levels of analysis' has been considered an important feature and it is necessary to categorise it. These levels are categorised as follows: (1) industrial level, (2) organisational level, and (3) internal level. Because the analysis on industrial and organisational levels does not look into internal processes of organisations, they are combined into one single category namely external level of analysis. Table 5.2 presents a description to these three levels of analysis classified in this study using the aggregation strata (Subsection 4.4.4). Therefore, it can be stated that most studies conducted their analysis at the external level. This means that less attention has been paid to directly examining how the dichotomy is reflected in internal processes of organisations.

Table 5.2 Level of Analysis

Level of Analysis	Description	Previous studies
External (Industrial)	• Analysis based on different industries or sectors • Focusing on 'interactions' and competition between organisations • Comparison between organisations in an industry	3
External (Organisational)	• Analysis based on different organisations • Focusing on 'behaviour' of the organisation, may consider impacts from factors, such as completion, but purpose of analysis is about how organisations may respond to them	63
Internal	• Analysis based on internal processes and functions in an organisation • Focusing on how internal processes and functions perform, also considering individual behaviours of employees	11

5.2.2 Summary of Previous Measurement of Key Concepts

Moving into some details on how previous studies have captured the conceptualisation of exploration and exploitation, notably, a closer look into the previous qualitative studies shows that the level of detail tends to offer limited insights into how exploration and exploitation are reflected in practice. Hence, this section will be mainly focus on how in quantitative studies exploration and exploitation are measured.

Table 5.3 offers the measurements for exploration, whereas Table 5.4 presents the measurements for exploitation. Here the different ways of measuring exploration and exploitation in the context of innovation management tend to vary in terms of: knowledge, managers' orientation and innovation outcomes. In addition to information provided in the table, it should be noted that there are also some 'popular' set of measurements among this list that have been used by other studies. For example, the measurements of Atuahene-Gima (2005) have been adopted by seven other studies, Jansen et al. (2006) by five studies and He and Wong (2004) by five studies.

Table 5.3 Measurements for Exploration

Author (s)	Description of measurements
Atuahene-Gima (2005)	· Acquiring manufacturing technologies and skills entirely new to the firm · Learned product development skills and processes (such as product design, prototyping new products, timing of new product introductions, and customising products for local markets) entirely new to the industry · Acquired entirely new managerial and organisational skills that are important for innovation (such as forecasting technological and customer trends; identifying emerging markets and technologies; coordinating and integrating R&D; marketing, manufacturing, and other functions; managing the product development process) · Learned new skills in areas such as funding new technology, staffing R&D function, training and development of R&D, and engineering personnel for first time · Strengthened innovation skills in areas where firms had no prior experience
Bauer and Leker (2013)	· New or radically improved processes introduced over last 5 years · Products or product lines, new to the company introduced to market over last 5 years
Benner and Tushman (2002)	· The percentage of patens that have citations on previous patens (self-citation + repeated citation)
Bierly et al. (2009)	· Frequency that outcomes occurred within the past three years as a direct result of: ➢ New products developed ➢ New processes developed ➢ New products and services offered to our customers ➢ New products and services not being easily copied by our competitors ➢ New approved patents or patent applications
Choi and Pham (2014)	· Willingness of an organisation to: ➢ Replacing existing products that have become obsolete in the market ➢ Diversifying into new businesses ➢ Offering product variety in the firm's main businesses
Clausen et al. (2013)	· We systematically search for new business concepts through observation of processes in the environment · The firm is constantly searching for new collaboration partners in order to develop our resource base · We systematically bring together creative and knowledgeable persons within the firm to identify new business opportunities · The board frequently discusses the firm's R&D policy · Firm management is involved in R&D processes · Firm management is participating actively in the development processes
Greve (2007)	· Innovations that the sources described as involving development of new technology or application of existing technology not earlier used by the focal firm
He and Wong (2004)	· Introduce new generation of products · Extend product range · Open up new markets · Enter new technology fields
Jansen et al. (2006)	· Our unit accepts demands that go beyond existing products and services · We invent new products and services · We experiment with new products and services in our local market · We commercialize products and services that are completely new to our unit · We frequently utilize new opportunities in new markets · Our unit regularly uses new distribution channels · We regularly search for and approach new clients in new markets

Author (s)	Description of measurements
Kim and Huh (2015)	· Innovation scope
Mcmillan (2015)	· Total number of Paten citations to and from university publications (per paper) that a firm has annually
McNamara and Baden-Fuller (2007)	· Granting of both patents and preclinical trials in R&D process for drug development
O'Cass et al. (2014)	· Strategic emphasis on: ➢ Discovering new opportunities in new markets and target new customers ➢ Inventing new products with unique features not available in competing products ➢ Discovering new ways to meet customer needs ➢ Acquiring product development skills and processes entirely new in the firm · To develop this new product: ➢ Acquired entirely new product development processes that had not been used before by the firm ➢ Acquired completely new manufacturing technologies and processes that had not been used before by the firm ➢ Acquired entirely new technology and innovation training skills for personnel development ➢ Set up completely new types of manufacturing facilities and operations
Quintana-Garcia and Benavides-Velasso (2008)	· The number of granted patents by the firm in a year that cite no other patents
Sok and O'Cass (2015)	· Introducing new generation of services · Extending service range · Opening up new markets · Entering new technology fields
Voss et al. (2008)	· Creating revolutionary new conceptual approaches · Experimenting with radical new works · Challenging traditional artistic boundaries
Yalcinkaya et al. (2007)	· Our firm chooses new approaches to processes, products and services that are different from those used in the past · Our firm has included some new aspects to its processes, products and services compared to prior strategy

Table 5.4 Measurements for Exploitation

Author (s)	Description of measurements
Atuahene-Gima (2005)	· Upgraded current knowledge and skills for familiar product and technologies · Invested in enhancing skills in exploiting mature technologies that improve productivity of current innovation operations · Enhanced competencies in searching for solutions to customer problems that are near to existing solutions rather than completed new one · Upgraded skills in product development processes in which the firm already possesses significant experience · Strengthened our knowledge and skills for projects that improve efficiency of existing innovation activities
Bauer and Leker (2013)	· Incrementally improved processes introduced over last 5 years · Substantially improved or incrementally new products, introduced to the market over last 5 years
Benner and Tushman (2002)	· The percentage of patens that have citation on previous patens (self-citation + repeated citation)
Bierly et al. (2009)	· Frequency that outcomes occurred within the past three years as a direct result of: ➢ Major product improvements ➢ Major process improvements ➢ Minor product improvements ➢ Minor process improvements
Choi and Pham (2014)	· Willingness to: ➢ Improving existing product quality ➢ Reducing personnel costs ➢ Reducing other input costs ➢ Improving the work environment and safety
Clausen et al. (2013)	· Compared to our competitors, we search more actively for new partners for competence development · Compared to our competitors, we cooperate more closely with our customers about innovation and R&D · Compared to our competitors, we cooperate more closely with our suppliers about innovation and R&D · The firm allocates resources to increase employees' competence · The firm emphasizes the importance of increasing the level of competence among employees · Employees are strongly stimulated to learn from their experiences
Greve (2007)	· Innovations that did not involve the firm learning or developing new technology
He and Wong (2004)	· Improve existing product quality · Improve production flexibility · Reduce production cost · Improve yield or reduce material consumption
Jansen et al. (2006)	· We frequently refine the provision of existing products and services · We regularly implement small adaptations to existing products and services · We introduce improved, but existing products and services for our local market · We improve our provision's efficiency of products and services · We increase economies of scales in existing markets · Our unit expands services for existing clients · Lowering costs of internal processes is an important objective
Kim and Huh (2015)	· Innovation depth
Mcmillan (2015)	· Total number of Paten citations to and from other firm publications (per paper)
McNamara and Baden-Fuller, 2007	· Three stages of human clinical trials (phases 1, 2, and 3) and NDA in R&D process for drug development

Author (s)	Description of measurements
O'Cass et al. (2014)	· Strategic emphasis on: ➢ Strengthening its existing position in its current markets. ➢ Improving efficiency of its current products ➢ Improving the quality of current products ➢ Improving its current product development processes and skills (e.g., increase the level of automation in operations) · To develop this new product: ➢ Improved its existing processes aimed at quality improvement of our new products ➢ Exploited mature, existing technologies to enhance the efficiency of product development ➢ Improved existing processes to reduce the cost of product development. ➢ Refined existing processes to reduce production time
Quintana-Garcia and Benavides-Velasso (2008)	· The number of patents that include one or more citations or self-citations
Sok and O'Cass (2015)	· Improving existing service quality · Improving service flexibility · Reducing service cost · Improving yield or reducing material consumption
Voss et al. (2008)	· Maximizing the contribution of our in-house artistic/production skills · Offering shows that stay close to our known strengths · Producing shows similar to those that have done well for us in the past
Yalcinkaya et al. (2007)	· Employees of our firm try to continuously improve the firm's processes, products and services · Employees of our firm believe that improvement of the firm's processes, products and services is their responsibility

Linking these measurements to the classification of levels of analysis presented in Subsection 5.2.1, these measurements are categorised into two categories of internal level and external level. The difference here is that whether the measurements listed need the investigation of internal organisational processes or the behaviour of employees and managers. With similar measurements merged together, Table 5.5 presents revised measurements for exploration and Table 5.6 presents revised measurements for exploitation. Based on these two tables, it seems that in the external level, exploration and exploitation are measured based on outcomes of certain processes or activities, whereas for the internal level they are measured based on decision-making. These measurements clearly have a wider scope than the original measures by March (1991), since he only used two sets of keywords to measure exploration and exploitation.

Table 5.5 Revised Measurements for Exploration

External	• New product/process/service/business model (including new generation of products) • Extend/open up existing boundaries/ranges of product/service • New market development or new customer segment acquired • Entering new technology fields • Number of 'new' patens (approved or applications) • Percentage that have citations on previous ones
Internal	• Learned/acquired technologies/skills that are entirely new to the firm in terms of: ➢ Product development process ➢ Manufacturing ➢ Managerial and organisational skills that are important to innovation ➢ Staff training/funding/supporting elements for R&D/NPD/innovation • Willingness to: ➢ Replace existing product ➢ Diversify into new business • Systematically/constantly search for: ➢ New business concept ➢ New collaboration partners ➢ Creative persons • The board frequently discuss R&D policy • Firm management is participating actively in R&D and development process • Accepting orders that has never been taken by the company

Table 5.6 Revised Measurements for Exploitation

External	• Introducing (improved/ incremental) product/process/service/business model • Improved existing product/service quality/flexibility • Reduced production cost for product or delivery cost for service • Improved yield or reduce material consumption • Extend existing market share (with existing product/service/business model) • Number of 'improved' patens (approved or applications) ➢ Percentage that have citations on previous ones
Internal	• Upgraded current knowledge and skills in terms of: ➢ exploiting mature technologies that improve productivity of current innovation operations ➢ searching for solutions to customer problems that are near to existing solutions rather than completed new one ➢ product development processes in which the firm already possesses significant experience ➢ projects that improve efficiency of existing innovation activities • Willingness to: ➢ Improving existing product quality ➢ Reducing personnel/other costs ➢ Improving the work environment and safety • Employees of our firm try to continuously improve the firm's processes, products and services • Employees of our firm believe that improvement of the firm's processes, products and services is their responsibility • Refine provision and implement small adaption to existing product/service/process • Encourage employees to learn from experience • Aiming at economics of scales in existing market

5.2.3 Limitations in Previous Empirical Design

Having revisited the research methods and measures used by previous relevant studies, this section will further evaluate these research methods and measurements. Overall, two limitations within previous methods and measurements have been noticed. Note that the limitations in previous empirical designs listed here result from the research questions of this study (Section 4.3). In terms of research methods, first, survey-based studies are dominant and there is a lack of explorative qualitative studies (for example, case studies). A lack of qualitative studies results in absence of details when examining internal innovation processes, which causes difficulties for understanding what exploration and exploitation mean in practices of managing innovation. Second, there is also a lack of industrial level of analysis, which may cause confusion on the definition and considerations for exploration and exploitation as capabilities (Subsection 4.4.4).

With regard to measuring exploration and exploitation, different conceptualisations of the dichotomy cause difference in measurements. Aligned with Subsection 4.4.4, studies at the external level of analysis often use outcome-based measurements. However, some of these measurements are equivalent to measuring radical and incremental innovation. For example, 'new product developed' is being seem as similar as the measure of radical innovation outcomes. Besides, measurements for the internal level of analysis are focused on decision-making, they do not seem to be closely related to the keywords found in March (1991) as his measurement (Subsection 2.2.1). It means that these measurements may not fully capture how exploration and exploitation are reflected in managerial practice of innovation because it moves away from the original postulations of March (ibid.)

Since the focus of this study is to investigate exploration and exploitation based on challenging the domain assumption of separating these two constructs, this has not been done in previous studies (see Subsection 4.4.2). Hence, it may require some different methods in addressing the research aim of this study. Also, this evaluation has reminded this study about the importance of designing a suitable research method for answering the research questions set. As a result, the next sections will demonstrate how this study identifies and design suitable research method.

5.3 Designing a Suitable Research method

After presenting the overview of previous research designs, the discussion will now move towards the design of empirical investigation. As a start, the research design should generally follow the process or logic of 'methodological fit'. For example, the 'research onion' proposed in Saunders et al. (2016 p. 124) suggested that the considerations such as research philosophy should be underpinning the methods chosen and data collected. Hence, the research design should start by discussing the research philosophy of the researcher. Based on this understanding, the following two subsections will first discuss methodological considerations for this doctoral study, concentrating on the research philosophy. This will include: the ontological and epistemological concerns, the research approach, along with the role of researcher in this study. In addition, this study has also developed and applied a model for designing a suitable research method. Therefore, the subsections after the methodological considerations will discuss why an additional process model for research design is used before presenting it.

5.3.1 Research Philosophy

Based on the research questions presented in Section 4.3, this subsection starts the discussion on methodological considerations for the research philosophy. For management studies, strong awareness of philosophical commitments underpins the choice of research approaches and strategies (Johnson and Clark, 2006). The research philosophy commonly refers to assumptions about how researchers view reality (Saunders et al., 2016, p. 124). This often contains assumptions about knowledge and the nature of the reality, which shape the researchers' understanding of the research questions, methods and interpretation of the research findings (Crotty, 1998). Different philosophical stances can then be further specific to (1) ontology, which is concerned with the nature of reality and existence, and (2) epistemology positions, which is about the ways of enquiring about the nature of the world (Easterby-Smith et al., 2012).

According to Grix (2004, p. 57), for all research studies, ontology considerations act as a starting point. More specifically, Bryman and Bell (2011, p. 20) point out that ontological positions are frequently referred to as objectivism and constructionism. Objectivism asserts that "*social entities exist in reality external to and independent of social actors*" (Saunders et al., 2016, p. 128). Constructionism presents the position that "*social phenomena and their meanings are continually being accomplished by social actors*" (Bryman and Bell, 2011, p.

22). Ontology indicates what may be known, then epistemology is about how the researcher can come to know it (Grix, 2004, p. 63).

Epistemology "*constitutes acceptable knowledge in a field of study*", and the best ways for inquiring about the nature of the world, to form respective merits of positions on how the research should be conducted (Saunders et al., 2016, p. 132). There are three stances of (1) positivism, (2) interpretivism, (3) realism. Specifically, Positivism asserts that "*the social world exists externally and that its properties should be measured through objective methods*" (Esterby-Smith et al., 2012, p. 22). Natural scientists often adopt this philosophical stance. In contrast, interpretivism believes that it is necessary to understand the differences between people as social actors and to grasp the subjective meaning of social action (Saunders et al., 2016, p. 136).

Taking the stance of realism means the view that "*there is a reality quite independent of the mind*" (ibid.). Based on these descriptions, realism is aligned with positivism in two aspects. First, a belief that both natural and social sciences can adopt the same approaches to the data collection and explanation; second, a view that an external reality exists, independent from our description of it (Bryman and Bell, 2011). It appears that realists take the views of positivist and interpretivist into account and aims to provide contextualized causal explanations. Realism has a structured ontological view combining positivism with interpretivism (Easton, 2010). It assumes that the world is real and objective and is independent of belief, experience, and human thoughts (Saunders et al., 2016). Although reality is there for observation, realism argues that sensory observation and measurement are not the only basis for explanation. This means that when studying the complex organisational processes and routine development, the researcher can get closer to the object of the study (ibid.). In this case, knowledge cannot be separated from the knower and is more related to how researchers interpret; therefore, the judgement of the researcher is important in analysing the information during and after it is being collected (Van de Ven, 2007).

Hence, this study adopts realism as its philosophical stance. This is because the interest of this study lies in making sense of a theoretical dichotomy of exploration and exploitation in the context of innovation management practices. The logic behind this interest is that managing innovation as a 'reality' may or may not be explained by this theoretical notion. In another words, exploration and exploitation provide a construct for explaining the reality. However, this study argues that this construct does not explain the reality well, because they are likely to be merely justified true belief (Subsection 2.4.2). This is done by creating a

'what if' and 'what if not' scenarios to investigate whether the notion of exploration and exploitation is valid in innovation management. As a result, this doctoral study is more suited to the philosophical stance of realism instead of other strands mentioned previously.

5.3.2 Research Approach

Selecting research approaches includes considerations on qualitative and quantitative approaches, and also reasoning approaches. Selecting qualitative and quantitative approaches requires additional considerations in the research design, (discussed in Subsection 5.4.3). For reasoning approaches, deductive, inductive and abductive represent the three most common ones inherent in the research design. Deductive reasoning refers to an approach that "*the conclusion is derived logically from a set of premises*", whereas inductive reasoning refers to conclusions being 'judged' by the 'observation made' (Saunders et al., 2016, p. 145). Arguably, research informed by realism often does not follow a pure inductive or deductive approach (Ragin, 2009).

Therefore, this research has adopted an abductive approach, which moves back and forth between theory and data by combining the deductive and inductive approaches. For an in-depth investigation of exploration and exploitation in practice, this study must first identify efficient management of these two activities. This of course requires a deductive approach. To see whether exploration and exploitation are separated, a deductive approach based on the keywords from March (1991) to define these two constructs is needed (see Subsection 2.2.1). In contrast, an inductive approach is also needed to generate new insights on explaining and describing innovation management. In the scenario where 'what if exploration and exploitation is not separated'. Hence, it seems that the abductive approach is more appropriate to this study.

5.3.3 Using Generic Design Model for Research Design

Besides the consideration and guidance from a methodological point of view, this study considered that these guidelines are lacking detail on the process of how to evaluate and select suitable methods. Hence, this research design followed a generic model derived from 'design and engineering' in order to have a more systematic approach in setting the final research methods. The model used in this research design is called 'Pugh's controlled convergence method'. In brief, the principle of this method can be described as a process of narrowing down alternatives of a design based on issues to solve and requirements, and refining and specifying these issues and requirements (Dekkers 2017, p.100; Kuppuraju et

al., 1985, p. 92; Sturges et al., 1993, p. 94). It is suggested that using this method in the design process can improve the integrity of the final solutions of design (Dekkers, 2017, p. 100).

In addition, the other reasons for referring to a generic design framework in the design process of the research are as follows. First, because this doctoral study may require different methods comparing to existing studies in exploration and exploitation, using a model ensure this research design to follow a relatively rigorous process for identifying suitable research methods. Second, as Edmondson and McManus (2007, p. 1173) state, the research process is not linear, rather, it is a *"journey that may involve almost as many steps backwards as forward"*. This is to say that design a research is not without trail-and-error. Therefore, having a model allows this research design to include a constant evaluation to identify and refine suitable methods.

5.3.4 Applying Design Framework for Research Design

Referring to the basic ideas from 'Pugh's controlled convergence method' to research design, a **Process Model** of research design for this study is developed. Figure 5.1 presents an overview of this **Process Model**. According to the Figure 5.1, this research design can be broadly divided into three phases. The first phase is about identifying the foundation for the design. This will include (1) the level of analysis, (2) the core issues that need to be addressed, and (3) the supporting requirements. A consideration of these three will lead to the identification of the general structure of the design. This is a general indication on how questions may be addressed in the empirical investigation. The second stage follows the principle of the controlled convergent method, starting from all possible solutions (in this case research methods), and then evaluating and discarding certain methods based on core issues and requirements. After this first evaluation, core issues and requirements will be refined, and the second evaluation will take place. This process will continue until the final design is identified. The third phase is about design synthesis and the logic of the final research methods. Therefore, the following section will present this process in detail, starting from identifying the foundations in the next section.

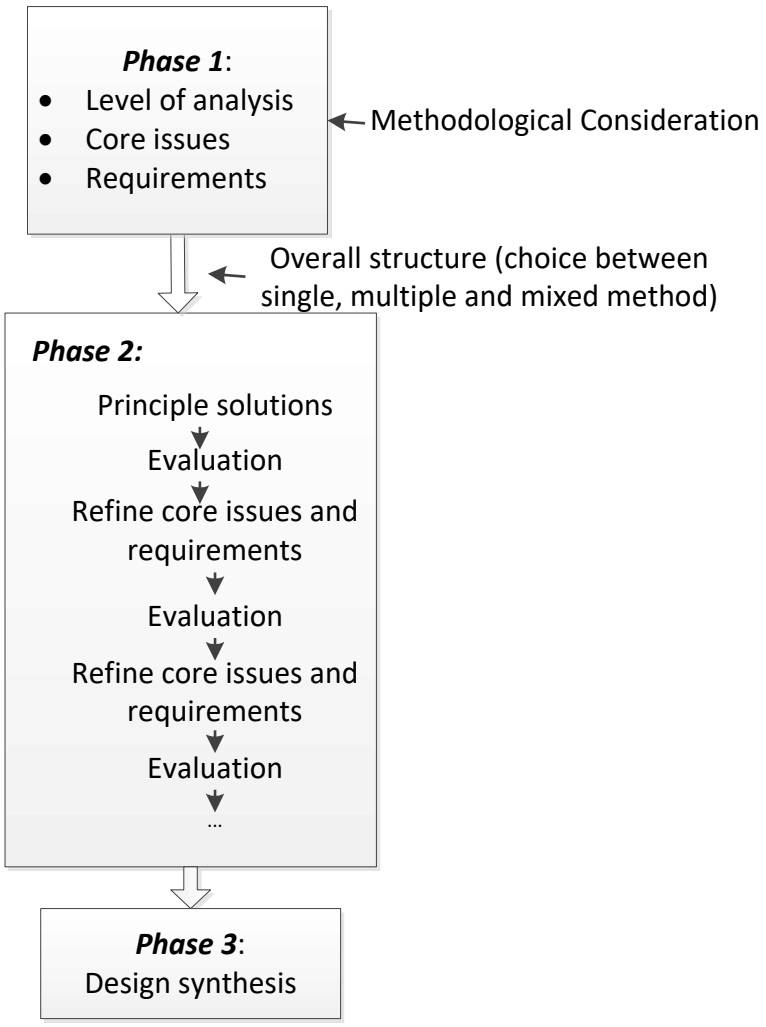


Figure 5.1 Process of Research Design

5.4 Identifying General Research Design

From this section onwards, the implication of the **Process Model** in this study will be presented. In this section, Phase 1 of the **Process Model** will be discussed in detail. Combining the discussion in the literature review, evaluation of previous research designs and research questions for this study, 'core issues' and 'functional requirements' will be identified. Also, based on the level of analysis, the general structure, which means the choice between single and mixed methods, is presented.

5.4.1 Identifying Core Issues

'Core issues' can be understood as the ultimate target this study wishes to achieve through the research design. These core issues reflect the research questions proposed in Section 4.3 and the need to verify the two arguments stated in Subsection 4.2.3. One thing to note as the principle of the controlled convergence method suggests, these core issues will be refined

through the process of method selection. Table 5.7 therefore presents the core issues that this research design needs to address.

Table 5.7 Core Issues

Core Issues	Description
Making sense of exploration and exploitation in practice	*The core focus of this study (as indicated in the title of this thesis)*
Challenging the domain assumption of separating exploration and exploitation	*The theoretical foundation of this study based on the two arguments (Subsection 4.2.3).*
Using exploration and exploitation as evaluation criteria for R&D outcomes	*Testing one of the ways of defining exploration and exploitation, based on the first research question*
Understanding exploration and exploitation both as evaluation criteria for R&D outcomes and internal processes	*To make clear the conceptualisation of exploration and exploitation by considering different level of analysis based on the second and third research question*
Understanding exploration and exploitation from a meta-theoretical perspective	*To ensure theoretical validation, this will also contribute to the fourth research question*

5.4.2 Listing [Functional] Requirements

By 'functional requirements' this study means the requirements that concerns practicality when selecting methods based on the fact that this is a doctoral study. These requirements also reflect what has been discussed in research or methodological guidence about validity and reliability (e.g. Tong et al. [2007] for qualitative studies; Saunders et al. [2016] pp. 450-452 for questionnaires). These requirements are identified to ensure both that the research design in this study is reasonable and achievable, and that the findings from the empirical evidence will make a contribution to scholarly knowledge. Similar to core issues, these requirements will be refined during the process of method selection. Table 5.8 presents the functional requirements that this research design needs to meet with descriptions provided for each requirement.

Table 5.8 Functional Requirements

Functional Requirements	Description
Limited time for conducting the research	*Because this is a doctoral study, hence, the 'power' of the researcher and the pressure of finish the empirical inquiry needs to be considered.*
Limited access to companies and industries as a doctoral student	
Evidence needs to be directly on justifying exploration and exploitation	*This is to deal with the lack of direct evidence in previous studies.*
Validity and reliability need to be ensured	*This is to ensure the quality of the empirical study.*

5.4.3 Structure of this Research: A Need for Mixed Methods

Taking into consideration the impact of different levels of analysis (see Subsection 5.2.1), it may be necessary to have a design that can cover both external and internal level analysis, with an emphasis on industrial level in external. This is because there are only limited studies shown in the literature review that focused on both levels. Furthermore, the analysis based on these two different levels of analysis may provide different information. Therefore, having a full justification of exploration and exploitation as both performance criteria and internal processes, requires a combination of evidence from both levels of analysis.

Hence, considering the core issues, requirements and the impact from the levels of analysis, this design first identifies a structure that can include and integrate different levels of analysis. The meaning of 'structure of design' is similar to what has been describe as 'research choice' in some other textbooks for research methods, which includes a choice between single (mono) method and multiple methods (e.g. Saunders et al., 2016, p. 143). As a result, this design will need to first make clear whether a single method or the use of multiple methods is more suitable to the purpose of this study.

Linking to the **Research Framework 1** (Subsection 4.4.3), it appears that the analysis based on industrial level well suit the purpose of performance evaluation using exploration and exploitation as criteria. Hence, the prospective methods to use at this level should aim at to answer the first research question of *"How to identify organisations that manage exploration and exploitation efficiently?"* and provide hints to the second research question of *"How does performance in terms of outcomes and resource allocation in the context of ambidexterity influence on-going decision-making on innovation management?"*.

Based on this understanding, it may be difficult to conduct this performance evaluation based on qualitative data and analysis. Quantitative methods emphasis the use of quantification in

the collection and analysis of data for a more external and objective reality (Bryman and Bell, 2011, p. 27). For performance evaluation, quantitative methods can provide comparable results between organisations, therefore, at industrial level, quantitative methods would be more appropriate.

Looking at the internal level of analysis, it appears that analysis at this level suits the focus of **Research Framework 2** (Subsection 4.4.6) focusing on internal innovation processes and systems. Hence, the methods for the internal level of analysis should be focusing on answering the second research question, especially the impact on decision-making in innovation management. Additionally, investigating on the internal level of analysis should contribute to the third research question on *"what the practical treatment of exploration and exploitation in is managing innovation"*. Furthermore, combining the results from the empirical study with the research framework should provide answers to the question of *"how an inseparable perspective of exploration and exploitation can contribute to innovation management"*.

Therefore, to better understand the internal processes of innovation, and the role exploration and exploitation played in these processes, qualitative data and analysis are required. Compared to quantitative methods, qualitative methods emphasise words rather than numerical data for understanding social reality (Bryman and Bell, 2011, p. 27). When investigating internal processes, qualitative methods will provide more detail on describing how innovation management works in practice based on the perspectives of individuals that are involved in these processes. As a result, for analysis in the internal level, qualitative methods are more suitable.

Considering the different purposes for analysis of the external and internal level, this study has designed the sequence of the quantitative methods from industrial level of analysis to be prior to the internal level of qualitative analysis. This is because for answering the second question on performance evaluation, it is necessary to first determine past performance based on the analysis at industrial level. Hence, this design will be following a mixed-method approach, with quantitative modelling based for the industrial level and qualitative methods based on the internal level within the selected industry. The mixed method is defined by its feature as *"the researcher collects and analyses both qualitative and quantitative data rigorously in response to research questions and hypotheses, integrates (or mixed or combines) the two forms of data and their results, organises these procedures into specific*

research designs that provide the logic and procedures for conducting the study, and frames these procedures within theory and philosophy" (Creswell and Clark, 2017, p .5).

It is clear that the logic of design in this study fits the definition of mixed method. In addition, because this design positions quantitative methods before qualitative method. According to literature and guidance specific to mixed method, this is called 'the explanatory sequential design' (Bryman and Bell, 2011, p. 636; Clark and Ivankova, 2016, p. 122; Creswell and Clark, 2017, p. 79). Using this as an overall design, results from the quantitative study will be explained by the qualitative study; here, it means the investigation into the internal innovation processes may explain the results of the performance evaluation.

To sum up, the first phase of this research design has identified core issues that needed to be addressed, functional requirements that needed to be considered, and the general structure of the design based on a mixed-method approach.

5.5 Method Selection for Industrial Level

In this section, evaluation and design from the industrial level of analysis will be presented. Note that although the processes of design external and internal level of analysis are presented in separate sections, it should be noted that these two processes will influence each other. Referring back to phase two of the **Process Model**, this process includes: (1) identifying and evaluating principle solution, (2) refining core issues and requirements, (3) evaluating again on solutions. An overview of methods identified for the industrial level of analysis will be presented in the next section.

5.5.1 Principle Solutions and Evaluation

Based on the core issues (Subsection 5.4.1) and functional requirements (Subsection 5.4.2), some principle solutions have been identified as the first step to the selection of method for the industrial level of analysis. In the stage of identifying principle solutions, this study has made attempts to include as many suitable methods as possible. To this purpose, few other sources discussing research methods were referred. These sources are Anderson et al. (2013), Bryman and Bell (2011), Cooper and Schindler (2011), Charnes et al. (1995), Saunders (2016), and Thomas (1997). After these methods were identified, core issues and functional requirements were used as criteria for evaluation. As a result, Table 5.9 presents these methods with descriptions and the outcomes of the evaluation.

Table 5.9 Principle Methods and Evaluation in Analysis of Industrial Level

Principle solutions	Description	Evaluation
Simulations	*A method for learning about a real system by experimenting with a model that represents the system and always includes controllable and probabilistic inputs (Anderson et al., 2013, p. 697)*	Fulfils the core issues if designed properly, however, the researcher is lacking relevant knowledge in this area. Hence, this can be time consuming.
Survey-based methods	*Using questionnaires to collect standardised data from a sizeable population, allowing easy comparison (Saunders et al., 2016, p. 181). Analysis can be based on descriptive and inferential statistics (ibid., p. 182)*	Fulfils the core issues and requirements
Experiment	*A form of research to study the probability of a change in an independent variable causing a change in another, dependent variable (Saunders et al., 2016, p. 178).*	Hard to achieve the purpose of performance evaluation
Linear programming (Data envelopment analysis)	*Linear programming is a method aiming at optimising problems subject to constraints (Thomas, 1997, p. 315). Data envelopment analysis (DEA) is a linear programming method that focuses on the performance of certain sets of entities (Charnes et al., 1995, p. 4)*	Fulfils the core issues and requirements
Content analysis	*An approach to the analysis of documents and texts that seeks to quantify content in terms of predetermined categories and in a systematic and replicable manner (Bryman and Bell, 2011, p. 291)*	Successful content analysis relies on the experience of the coder to have sufficient experience in practice, which the doctoral student does not possess such experience.
Game theory related modelling	*Using game theories to model and understand an optimal decision alternative after considering the possible outcomes of one or more chance events (Anderson et al., 2013, p. 166). Game theory means the study of decision situations in which two or more players compete as adversaries (ibid., 174)*	Focusing on decision and behaviours of organisations rather than past performance. No correct to use this without knowing exploration and exploitation have impact on ongoing decision making
Forecasting related methods	*A method that aims to generate reliable estimates of future values (Thomas, 1997, p. 220). Two main types of forecasting methods are causal forecasting and time series analysis (Anderson et al., 2013, p. 183)*	Knowing how organisations may perform in the future is not the main focus of the quantitative part of the study.

Based on the core issues that needed to be addressed, together with the requirements, some methods can be discarded based on the first stage of evaluation. According to Table 5.9, these methods were discarded because they do not fulfil the need to address the core issues (experiments, forecasting related methods and game theory related modelling) or not meeting the functional requirements (simulation and content analysis).

5.5.2 Refining Core Issues and Requirements

After the first evaluation, survey-based methods and data envelopment analysis are left for further evaluation. This study has first considered the possibility to include both methods. However, this was unsuccessful. These two methods serve different purposes and therefore, it is hard to find ways to combine them for having added value for the study. As a result, since the core issues and functional requirements used in the first evaluation are general, these need to be further refined with more detail on the industrial level of analysis for a second evaluation of these two methods.

Reviewing again the functional requirements, there will not be additional or more specific functional requirements needed for further evaluation. In terms of core issues, it is noted that some core issues are not specific for the quantitative analysis (for example, making sense of exploration and exploitation in practice) so that they can be revised. As a result, the core issues for the second evaluation are refined as: (1) the results from the quantitative study into performance of each organisation should be comparable, (2) ensuring benchmarking within selected industries, (3) exploration and exploitation is defined based on both input and output based on the **Research Framework 1** (see Subsection 4.4.4).

5.5.3 Second Evaluation

Using the refined core issues and requirements, the second stage of evaluation can take place. Table 5.10 presents the outcomes of this second evaluation. According to the table, methods that are less suitable are discarded and the selected research method on analysis of industrial level is identified to be data envelopment analysis.

Table 5.10 Second Evaluation in Industrial Level of Analysis

	Survey-based methods	Data Envelopment analysis
Results from the quantitative study should be comparable	Yes	Yes
Ensuring benchmarking within the selected industry	No	Yes
Exploration and exploitation are defined based on both input and output based on the research framework	No	Yes

5.6 Method for Analysis of Industrial Level

Having selected data envelopment analysis (DEA) as the method for industrial level of analysis, this section will provide a brief overview to introduce this method. This overview includes the concepts and basic models of DEA. Detailed design on aspects such as data, sampling and application of the method in this study will be presented later in Chapter 6.

5.6.1 Overview of Data Envelopment Analysis

By definition, data envelopment analysis (DEA) is a mathematic modelling method that focuses on the performance of certain sets of entities (in this case they are been called decision-making units) with multiple inputs and outputs (Charnes et al., 1995, p. 4; Cooper et al., 2011, p. 1). Since it was first introduced, DEA has been regarded as an excellent alternative of measuring and evaluating performance of decision-making units. Furthermore, it has also been regarded as providing more insight than other methods in conditions that the relationship between multiple inputs and outputs are complex or unclear (Cooper et al., 2011, p. 2).

Data envelopment analysis (DEA) is often used for analysis of the 'efficiency' of a certain set of decision-making units. In some case, this method can be used to identifying the 'best-practice' of decision-making units (Cook et al., 2014). This feature has made DEA a good fit for this research purpose because measuring efficiency considers both resource allocation and outcomes. The frontier of the evaluation is defined as 'most efficient' within the industry so that organisations that form this frontier can be identified as ambidextrous based on the conceptualisation of ambidexterity (Subsection 4.4.5). Consequently, it would provide insights to examining exploration and exploitation as evaluation criteria for R&D.

5.6.2 Basic Models in Data Envelopment Analysis

Since it is first proposed, there are four models that are considered fundamental in data envelopment analysis (DEA) (Cooper et al., 2011, p. 35). Before presenting these four basic models, this study will need to first discuss two important elements of DEA. These include model orientation and return to scale. First, regarding model orientation, because DEA aims to benchmark performance based on both inputs and outputs of certain process, the outcomes of DEA models will suggest two different ways of improvement. Generally, based on the 'best-practice frontier' as the outcome of DEA, the results will suggest either 'minimise input' or 'maximise output' as ways for inefficient units to reach the frontier (Cook et al., 2014, p. 2). Hence, input-orientated models will be focused on providing indications from the input side, whereas the output-orientated models are aiming at providing solutions focusing on the output side.

Second, in terms of return to scale, as a concept originating from economic studies, it is defined as the relationship between the rate of increase in output and the associated changes of relative inputs (Banker et al., 2011, p. 42). Based on this definition, there will be three possibilities for return to scale, namely constant return to scale, increased return to scale and decreased return to scale. In DEA, increased return to scale and decreased return to scale can be categorised as instance of the variable return to scale. Constant return to scale assumes that the increase of outputs is equal the proportional changes in inputs, otherwise, the return to scale is considered as variable (ibid.). Based on this understanding, Table 5.11 presents the four basic models for DEA. Note here that the abbreviation of the models represents the authors who proposed them.

Table 5.11 Basic Data Envelopment Models

	Model Orientation	**Return to Scale**
BCC-Input	Input	Variable
BCC-Output	Output	Variable
CCR-Input	Input	Constant
CCR-Output	Output	Constant

5.6.3 Purpose of Using Data Envelopment Analysis

In addition to the reasons for selecting data envelopment analysis (DEA), based on the evaluation between different quantitative methods, the application of DEA also serves the following purposes. First, DEA will be used for evaluating organisations' R&D performance as indicated in the first research question. Specifically, this evaluation using DEA will be

based on benchmarking among organisations within the same industry. Second, because DEA considers both input and changes in output, it covers the definition of exploration and exploitation in this study. The results of DEA are able to provide an indication of organisations that can be identified as ambidextrous. Last, the outcomes from DEA (i.e. the ambidextrous organisations identified) provides a link with qualitative part of this study. This is to say that, the selection of sample from qualitative part of the study can be based on the outcomes from DEA. This point will be elaborated in Subsection 5.9.2.

5.7 Method Selection on Internal Level

In this section, the method selection and evaluation for analysis of the internal level will be discussed. This selection is similar to the one on the analysis of industrial level includes identifying and evaluating principle solutions, refine core issues and requirements, and second evaluate on solutions. An overview of methods identified for this level of analysis will be presented in the next section.

5.7.1 Principle Solutions and Evaluation

Some qualitative methods as principle solutions are listed first. Sources for these methods include Bryman and Bell (2011), Cooper and Schindler (2011), Gummesson (2000), Eriksson and Kovalainen (2008), Ritchie et al. (2014), and Saunders (2016). Based on the core issues that need to be addressed, together with the requirements, some methods can be discarded after the first evaluation. Table 5.12 presents the methods and the first evaluation based on core issues and requirements. These methods were discarded during the first evaluation, because they failed to address core issues (action research, grounded theory, narrative research, discourse analysis) or do not meet the functional requirements (observations, ethnography).

Table 5.12 First Evaluation on Principle Solutions in Internal Level of Analysis

Principle Solutions	Description	Evaluation
Action Research	*A method that the research process includes close collaboration with the research object and its practical problem solving by the researcher (Eriksson and Kovalainen, 2008, p.193)*	Does not fit to the purpose of investigating of exploration and exploitation in practice
Case Studies	*An empirical enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident (Yin, 2014, p. 16)*	Fulfils the core issues and requirements
Focus Groups	*A structured group discussion with selected individuals on a specific topic (Litosseliti, 2003, p.1)*	Fulfils the core issues and requirements
Ethnography	*A method that the researcher immerses him or herself in a group for an extended period of time, observing behaviour, listening to what is said in conversations both between others and with the fieldworker, and asking questions (Bryman and Bell, 2011, p. 426)*	Fulfils the core issues but may need permission of access to organisations. Hence, may not fit functional requirements.
Interviews	*A method for generating description and interpretation of people's social worlds with a form of conversation (Yeo, et al., 2014, p.178)*	Fulfil the core issues and requirements
Grounded Theory	*A method that consists of a specific set of procedures for carving out the inbuilt middle-range theory, which means theories that are delimited to specific aspects of social phenomena instead of broad abstraction, from and with the help of empirical data (Eriksson and Kovalainen, 2008, p. 154)*	This method often starts with data and then to theories. Hence it may be difficult to apply **Research Framework 2** to the analysis.
Narrative Research	*This method is based on the ideas of 'narrative knowing' and 'storytelling' as basic human activities and collect and analyse data based on 'narrative writings' or stories (Eriksson and Kovalainen, 2008, p. 224)*	Suitable in making sense of exploration and exploitation in practice but may be difficult to link these to **Research Framework 2**. Hence, may not achieve reflection from meta-theories.
Discourse Analysis	*A method that focuses on cultural meanings attached to people, artefacts, event and experiences (Eriksson and Kovalainen, 2008, p. 227)*	The focus of this method is not fit the purpose of this study.

5.7.2 Refining Core Issues and Requirements

For further evaluation, core issues and requirements need to be further refined with more detail on the analysis of the internal level. Since the qualitative study will follow the quantitative study and the two are related, one of the functional requirements regarding access and time consideration is refined as: access for the companies contained in the quantitative study and sufficient time to develop a validated and reliable study. In addition, to the internal level of analysis, some detailed core issues are refined and added as followed: (1) capturing and mapping the internal process of organisations, (2) examining the dichotomy directly in practices according to **Research Framework 2** and (3) linking with the quantitative part of the study

5.7.3 Second Evaluation

Based on the refined core issues and requirements, Table 5.13 presents the second evaluation of methods. According to the table, case studies, especially with multiple case studies design, may be difficult due to the limited time and access. However, there is an attempt to use case studies in previous versions of research designs, see Appendix II for the reasons why this does not work in the end. This study then considers the possibility of combining interviews and focus groups. It seems that interviews are beneficial for generating insights from specific individuals, whereas focus groups can generate collective understanding on certain themes. Hence, the data from these two methods can complement each other. This combination will be further discussed in Subsection 5.8.5. As a result, the methods selected in the internal level of analysis is a focus group supplemented with interviews.

Table 5.13 Second Evaluation in Internal Level of Analysis

	Case studies	**Interviews**	**Focus groups**
Access for the companies that are contained in the quantitative study	No	Yes	Yes
Sufficient time to develop a validated and reliable study	No	Yes	Yes
Capturing and mapping the internal process of organisations	Yes	Yes	Yes
Provides link with quantitative study	Yes	Yes	Yes

5.8 Method for Analysis of Internal Level

With focus groups supplemented by interviews identified as the research method for analysis of the internal level, this section will provide a brief overview to describe this method. This overview will only include the basic concepts, benefits and challenges of focus groups and briefly discuss how interviews can supplement this method. Chapter 7 will provide further detail on the design and cover: data collection, sampling, and how interviews and focus groups are implemented in this study.

5.8.1 Overview of Focus Groups

By definition, the focus group refers to a structured group discussion with selected individuals on a specific topic (Litosseliti, 2003, p. 1 and Wilkinson, 1998, p. 182). A typical focus group often involves two parties, the participants and the facilitator or moderator (Parker and Tritter, 2006, p. 26). Here, the facilitator will be pointing out the themes or questions to be discussed within the group, whereas the participants will be sharing and discussing their comments and responses toward a set of questions or themes (ibid.). As pointed out by many studies, one of the most important elements in focus group is group interactions (e.g. Kitzinger, 1994, p. 106; Morgan, 1997, p. 3; Bloor et al., 2001, p. 8). Furthermore, Wilkinson (1998, p. 182) points out that the group interaction should be mainly about the interaction of participants rather than between the moderator and the group. That is to say the role of a moderator in a focus group should be guiding the discussion and listening to the views instead of participating and engaging in the discussion (Krueger, 1998, p. 5). To sum up, focus group is a way to collect different views from participants on a selected topic through group interaction, guided by a moderator.

5.8.2 Focus Groups as a Research Method

In its early applications, the method of focus groups is mainly used in marketing for collecting information on customers' feedback and views on certain products or promotions. Later, focus groups have been used in social and political science. Here, their main function has been to assist collecting data that covers the different perspectives within diversified groups (genders, ages, educational levels etc.). Recently, the use of focus group has been extended, with applications in management studies. Throughout its development, focus groups have had different features suiting not only marketing researches, but also other social science research (Liamputtong, 2011, p. 12).

When considering focus group as a research method, it arguably is mostly identified as a qualitative method. It has been pointed out that focus groups are unique only in terms of data collection, since the data analysis shows similarity to other qualitative methods (e.g. content and thematic analysis) (Wilkinson, 1998, p. 182). This point of view is supported by other authors writing about focus groups. For example, Bloor et al. (2001, p. 8) pointed out that focus groups are better suited to use as an adjunct to other methods, rather than as a stand-alone method. This is because the additional insights a focus group could be generated through group norms and group understanding. As a result, they further summarised how focus group can be operating at the beginning, middle and end of research projects.

In contrast, there are studies that have discussed and applied focus groups as a stand-alone method. In respond to one of the so called 'myth' of focus group that it must be validated by other methods, Morgan (1998, p. 51) pointed out that whether the outcomes of the focus group are sufficient to support certain research objectives is depending on whether the study requires generalisability of these outcomes. Wilkinson (1998, p. 185) provided examples of how focus group can be used to: (1) explore new area or research questions, or (2) examine existing areas or research questions. Similarly, Kitzinger (1994, p. 106) and Liamputtong (2011, pp. 16-25) have also provided examples of how focus groups can work in different theoretical settings. Hence, these examples have proven that in certain research settings, the method of focus groups can be considered as valid as a 'stand-alone' method.

In management studies, a focus group can be used within or among organisations. Using this method within an organisation, a focus group will be act as a data collection method that contributes to case studies. This study has noted that the use of focus groups in other doctoral theses are mainly falling under this category. In terms of application among organisations, focus groups can be used to collect different views from different companies. For example, Dekkers et al. (2019) used focus group as a 'stand-alone' method to investigate supply chain and finance integration. Hence, using focus groups as a research method is a valid way of doing management research and it can bring insightful outcomes. Further specific reasons on when and why should a focus group study should be used will be discussed in the next subsection.

5.8.3 Benefits and Challenges in Focus Group Study

Based on the understanding that focus groups can be considered as a 'stand-alone' research method, this subsection will discuss the benefits and challenges of using focus groups as

research method. Table 5.14 lists a summary of benefits and challenges of focus groups method discussed in previous works. According to the table, using focus groups as part of the research methods for the analysis of the internal level can bring additional insight into the core issues of the investigation. The purpose of using a focus group will then be briefly discussed in the next subsection.

Table 5.14 Benefits and Challenges of Using Focus Groups

Benefits of focus groups	Cheap, quick, and easy to run
	Useful in obtaining a number of different perspectives
	Generating useful insights through group interaction
	Gaining information on participants' views, attitudes, beliefs, responses, motivations and perceptions on certain topics
	Concentrated amounts of data
Challenges of focus groups	Less naturalistic observation comparing to 'participant observation'
	Depending on participants' involvement on certain topic, may cause rich data in one topic and limited data on the other
	Individual view may be influenced by the group view
	May be hard for generalisation

Source: Benefits: Wilkinson (1998, pp. 186-188), Liamputtong (2011, pp. 5-8), Litosseliti (2003, pp. 16-20), Kitzinger (2005, p. 56). Challenges: Wilkinson (1998, pp. 186-188), Liamputtong (2011, pp. 8-9), Litosseliti (2003, pp. 20-27), Morgan (1997, pp. 13-17).

5.8.4 Purpose of Using Focus Group

This study intends to conduct a focus group study among different companies as part of the qualitative stage of the empirical study. More specifically, the selection of this method is also based on the following two reasons. First, using focus groups contributes to 'make sense' of exploration and exploitation in practice and answering research question 3. Here, the 'group understanding' is key, meaning the focus group will be able to capture different views on how different companies 'practice' exploration and exploitation in their innovation activities or processes. Notably, this should be done without telling them too much what the notion means. It would be expected that some sort of collective understanding can be achieved. Furthermore, it may also be possible to see how companies in different positions (ideally based on the outcomes of performance evaluation from the quantitative method) may think of exploration and exploitation differently.

Second, the overall purpose of the qualitative study is to investigate innovation management based on the **Research Framework 2** proposed in Subsection 4.4.6. The 'focuses of the

focus group can be developed according to this framework, and a relatively open discussion on innovation management will provide insight to the fourth research question. As a result, a focus group is suitable as part of the method in the qualitative part of this study investigating the internal level.

5.8.5 Combining Focus Group with Interviews

As different methods of data collection focus groups and interviews often provide different types of data (Bloor et al., 2001, p. 17). The method of interviews could provide more control for data collection, which means that there is a need for in-depth information from participants. Based on this distinction between focus groups and interviews, Morgan (1997, p. 13) stated that it is possible to combine the methods together to strengthen the research design. As stated by Morgan (ibid., p. 24) that "*focus groups and individual interviews can be complementary techniques across a variety of different research designs. In particular, either of them can be used in either a preliminary or a follow-up capacity with the other. This illustrates the larger point that the goal of combining research methods is to strengthen the total research project, regardless of which method is the primary means of data collection*." For data triangulation, management studies often use interviews and focus groups as data collection method for the case study methodology. Without considering this 'case study method' as the context, either focus groups or interviews can be regarded as the primary research method. As a result, how to combine these two methods in this study depends on how the detailed design of the qualitative part of the study can be beneficial to addressing the research questions. This detailed design will be discussed in Subsection 7.3.

5.9 Design Synthesis

This section will discuss the third phase of the model for research design. Having already identify a mixed method design and complimentary quantitative and qualitative, this section will then demonstrate the final outcome of this research design. Specifically, the following subsections will present a review of how the model was applied in this study and shows the logic and procedure of how the empirical part of this doctoral study will be conducted.

5.9.1 Summary of the Design Process

This research design has referred to the generic controlled convergent method and developed a **Process Model** for the research design (Subsection 5.3.4). Figure 5.2 presents an overview of the application of the **Process Model** in the research design. Through the design process,

multiple versions of research designs were developed that turned out to be not feasible to conduct. Hence, some of previous versions of the research design are shown in Appendix IV. As a result, the finalised research design that is leading the empirical part of this study is presented in the next subsection.

5.9.2 Procedure of the Empirical Study

The research design for this study is finalised as mixed methods with data envelopment analysis (DEA) for the quantitative part at industrial level and focus group supplemented by interviews for the qualitative part looking into organisational processes. More specifically, the empirical part of this study will start with DEA in selected industries for a evaluation of R&D outcomes, using exploration and exploitation as criteria, identifying ambidextrous organisations.

The qualitative study will then take place. Interviews will be conducted with at least one of the identified ambidextrous organisations and focus groups will be arranged including some of the organisations in the sample of the quantitative part of the study. The findings after data collected have been analysed using these methods are expected to provide insight to the research questions. Table 5.15 presents how the findings from different method may contribute to the four research questions in Section 4.3.

Table 5.15 Linking Expected outcomes to Research Questions

Expected outcomes	Contributing to Research Questions
Results from DEA (Chapter 6)	A way of using exploration and exploitation as evaluation criteria
Interviews with people from companies included in DEA (Chapter 7)	Understand whether exploration and exploitation have impact on on-going decision-making during innovation processes
Findings from interview and focus group (Chapter 7)	Making sense of exploration and exploitation
Findings from DEA, interviews and focus groups (Chapter 8)	Contributing to innovation management framework

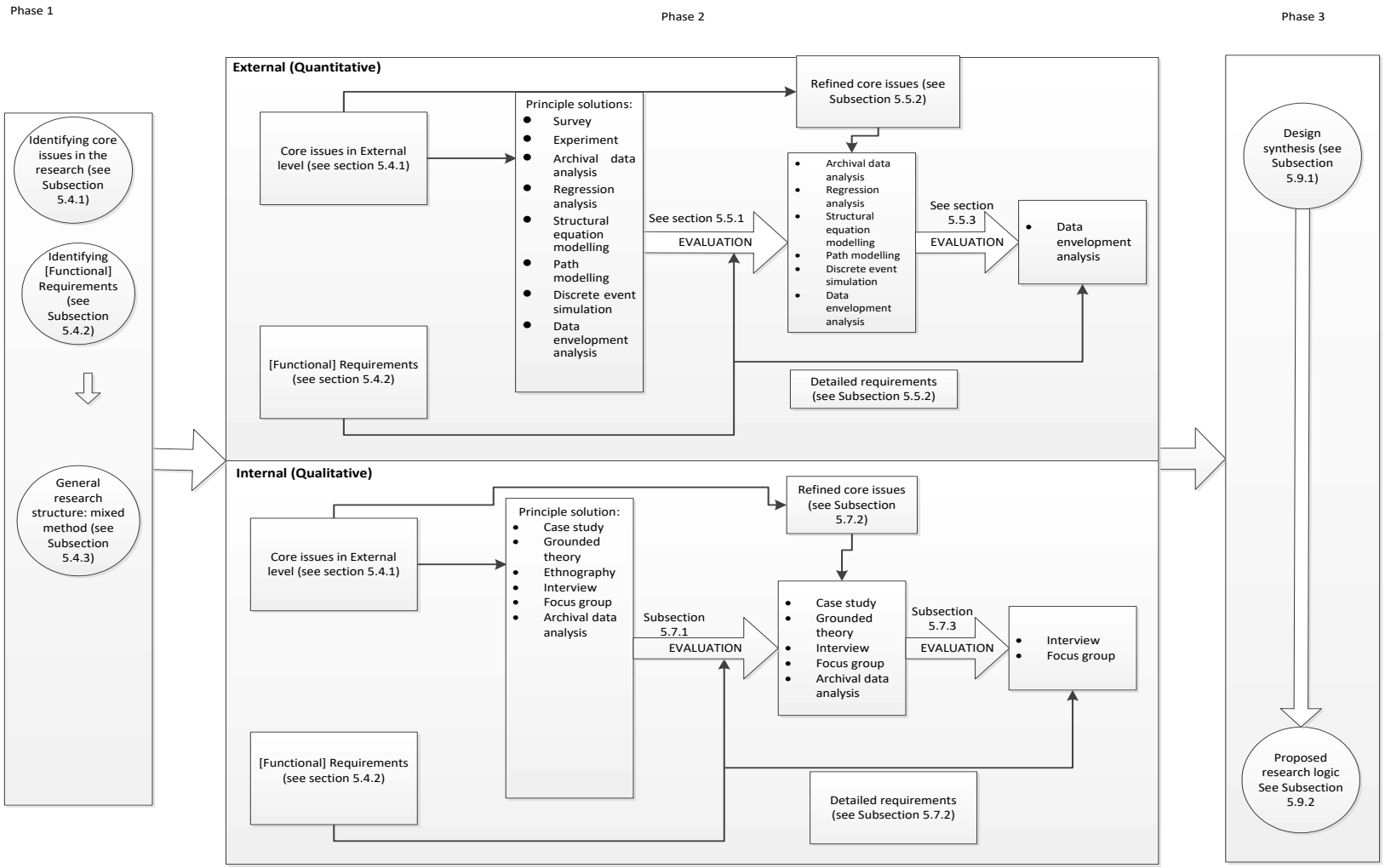


Figure 5.2 Summary of research design

5.10 Summary of Chapter 5

This chapter has presented how this study has designed its empirical investigation of exploration and exploitation in practices for innovation management. As the outcome, the empirical part of this study will take a mixed-method approach that includes quantitative and qualitative methods based for the different levels of analysis. The outcome of this research design allows this study to proceed to collect and analyse empirical data for investigating exploration and exploitation in practice. This investigation will be presented in detail in Chapter 6 for the quantitative part and Chapter 7 for the qualitative part. Key points of this chapter are as follows:

- Research designs from previous studies are evaluated. Limitations in previous research designs are identified, providing useful points for this research design to pay attention to.
- This study takes a realism philosophy stance using an abductive approach.
- Combining with the need for different levels of analysis, this study selected a mixed-method structure in its design.
- The research design is based on the **Process Model** for research design developed from a design and engineering model (Pugh's controlled convergence method). This starts with identifying core issues and requirements, and then evaluating principle solutions accordingly. This evaluation will go on with refined core issues and requirements until final methods are finalised.
- The method selected based on this evaluation process for the quantitative part of this study is data envelopment analysis.
- The methods selected in the qualitative part of this study is a focus group supplemented with interviews.
- This study will conduct the quantitative part of the study before the qualitative part. This study will use the result of the quantitative part as sampling criteria for the qualitative part. Methods from both parts and their combination are expected to provide answers to the four research questions.

Chapter 6 Ambidexterity as Benchmark: The Quantitative Part of Study

6.1 Introduction

The aim of this chapter is to present and discuss the quantitative part of the empirical study viewing exploration and exploitation as performance criteria. This includes the application, detailed design, results, and discussion of findings of data envelopment analysis (DEA). Since this is the first attempt of using DEA to study exploration and exploitation, a validation study using a different source for data to examine the outcomes of DEA was included. Section 6.2 will present the process of selecting suitable DEA models related to the discussion in Subsection 5.6.2. This includes the aspects of decision-making units, model orientation and return to scale. Section 6.3 will move on to the measurements for exploration and exploitation including how data was collected and prepared for the analysis. Section 6.4 will show results from DEA with explanations about how the results are interpreted, followed by discussions that leads to the findings. Section 6.6 then provide the process of the additional validation, including source of data and results. Based on this validation, Section 6.7 will present a summary of key findings from DEA.

6.2 Research Model: Selection and Development

The research design presented in Chapter 5 has identified data envelopment analysis (DEA) as the main research method for understanding exploration and exploitation as performance criteria for innovation and identifying ambidextrous organisations. With the rationale for using DEA presented in Section 5.6, the following subsections will be focusing on the application of DEA in this study.

6.2.1 Key Aspects for Model Selection

Considering the benefit of using data envelopment analysis (DEA) as a method for benchmarking and performance measurement, Table 5.11 has listed four classic models of DEA. These include BCC (output orientated), BCC (input orientated), CCR (output orientated) and CCR (input orientated). As the method of DEA is not context specific, these applications have provided evidence that DEA can be useful in evaluating performance by selecting appropriate inputs and outputs accordingly to the context and specific to research questions. Hence, basic models of DEA were used for evaluating R&D performance of organisations.

The reason to only use basic models of DEA is that the overall implementation of this method builds on these classic models (Cooper et al., 2011, p. 14). To provide guidance for selecting

suitable DEA models, Cook et al. (2014, p. 1) have pointed out five questions for consideration before applying the method. These considerations are: (1) the purpose of performance measurement and analysis, (2) the decision-making units (DMU) and the outputs and inputs to be used to characterise the performance of those DMUs, (3) the appropriate model orientation, (4) the appropriate types of return to scale, and (5) an appropriate number of DMUs, given the number of inputs and outputs chosen. This study will then use these five questions to determent a DEA model for evaluating R&D performance.

6.2.2 Purpose of Performance Measurement and Analysis

The first question to consider is the purpose of performance measurements and analysis. According to Cook et al. (2014, p. 1), it is important to determine the 'process' or 'function' being studied using DEA. The overall performance measured here is the R&D performance of each organisation in the sample. This means that the selection of inputs and outputs for the model will only be related to R&D, items such as marketing expenditure and sales of new products will not be considered as appropriate.

6.2.3 Decision-making Units, Inputs and Outputs

Moving on to other features of DEA, decision-making units (DMUs) in this study will be companies operating in selected industries that fit selection criteria; see details of sampling procedure in Subsection 6.3.5. The input of this study will be R&D expenditures and the output will be patent counts (see justification of measurements in Subsection 6.3.2). The basic requirement of data envelopment analysis (DEA) is that input can generate output, output can be generated by input (Charnes et al., 1994, p. 4). In this study, the selected input and output are related to the R&D function of organisations, and R&D expenditure and patent fit this basic requirement of conducting DEA (Subsection 6.3.2). Additionally, patents will be counted and further categorised into two types (the count will be based on self-citation, see Subsection 6.3.3). Here, the two outputs will be correlated. However, it is indicated by Kalirajan and Shand (1999, p. 150) that it would not affect the accuracy of the results from DEA if different inputs or different outputs are correlated.

6.2.4 Return to Scale and Model Orientation

In evaluating R&D performance, it is logical to say that bigger companies might be more likely to generate larger number of patents. Hence, looking at the outcomes of R&D, the

output in terms of patent is related to the size of the company. It is then reasonable to consider return to scale to be variant rather than constant to minimise the impact of size of organisations (Subsection 5.6.2). Here, return to scale specifically refers to whether the increase of R&D output is equivalent to proportional changes in R&D inputs. This consideration can be formulated as, for example, in a simplified situation, if the increase in R&D input is doubled, the R&D output would be doubled as well; if this is the case, then the return to scale should be considered as constant. However, because the outcomes from R&D are usually uncertain (Balachandra and Friar, 1997, p. 277), having a variant return to scale seems more reasonable. Specifically, variant return to scale in this study means that proportional change in R&D input may have an unknown effect on R&D output. For instance, increased R&D input by two-fold may not result in the same increase in R&D outputs. Hence, the model selected in this study will be based on a variant return to scale.

In terms of model orientation, it means that the evaluation results will indicate improvements for DMUs based on increasing output or decreasing inputs (Section 5.6). Considering the nature of innovation activities, the outcome of innovation is often unpredictable. Hence, it seems reasonable to choose an input-oriented model. However, the original level of inputs may vary across the sampled organisations, and simply using an input-orientated model may cause the indicated improvement unrealistic; see Section 6.4 for more detail. Hence, an analysis based on an output-oriented model is also included in the study, which enables this study to generate findings relevant to both input and outputs of R&D.

6.2.5 Sample Sizes

Cook et al. (2014, p. 2) have pointed out that if the number of input and output items are too large compared to the number of decision-making units (DMUs), inaccurate results may occur. However, they also stated that consideration of sample sizes in data envelopment analysis (DEA) have less impact on the accuracy and the reliability of the results compared to other methods such as regression analysis. Therefore, Zhu (2014, p. 3) pointed out that the ideal sample size for DEA should be no less than three times the number of inputs plus outputs. In this study, this means because it used one input and two outputs (in total 3), from any sectors selected, the sample will be acceptable if it is larger than nine (three times three)

6.2.6 Research Model for DEA

Taken all the considerations on model selection discussed in the previous subsections into account, this study will analyse data based on the BCC model, both input and output oriented (see Table 5.11). Figure 6.1 shows the research model adopted from **Research Framework 1** for this part of the study using data envelopment analysis. The research model represents the R&D process within the innovation process presented in **Research Framework 1**. According to Figure 6.1, exploration is captured by transforming R&D input to radical R&D output, whereas exploitation is captured by transforming R&D input to incremental R&D output. Discussion on how radical and increment R&D outputs are measured will be present in the next section.

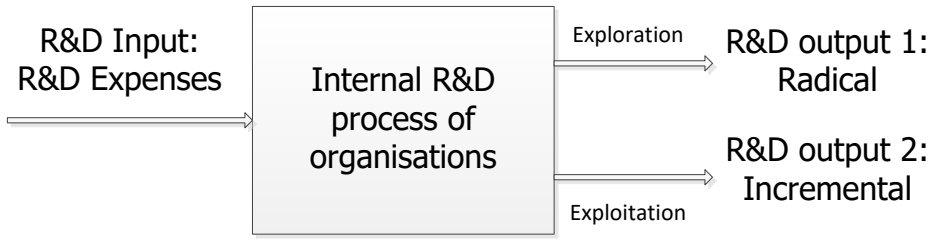


Figure 6.1 Research Model for DEA

6.3 Measurements and Data Collection

Whereas the previous section has demonstrated the research model for this study, this section will move to further details on measurements and data collection. Since exploration and exploitation are defined as criteria based on **Research Framework 1**, the following subsections will present how this study settled measurements for these two criteria. Sampling and data collection will be the foci of the last four subsections.

6.3.1 Using Secondary Data to Measure Innovation

This subsection focuses on what data to use. In general, there are two types of data to consider when undertaking quantitative study: primary and secondary. Primary quantitative data often collected by questionnaire capturing 'self-reported' innovation outcomes. Based on a systematic literature review by Becheikh et al. (2006, p. 650), between 1993 and 2003, around 24% of empirical studies in innovation used firm-based surveys to collect data. Considering the data collected through questionnaires, there are two limitations to be noted especially for this study. First, since data envelopment analysis (DEA) is chosen as the method, the purpose of the study is different than survey-based research designs. This is to

say that for DEA, it would be beneficial using data sources that depend on the 'actual amount' of input and output from organisations rather than self-reported results. Second, taking into account temporal and resource limitations of a doctoral study, it may be difficult to capture a comprehensive picture within a certain context using survey data, especially with regard to response rates. Therefore, for this study using primary data sources does not fit its purposes.

This brings up the other option of using secondary data from publicly available sources. The use of publicly available data to measure innovation became popular since 1980s, and in the early stages of using this type of data source, studies emphasised innovation inputs (Bain and Kleinknecht, 2016, p. 1). After the limitation of the lack of measurements on the 'output' side being pointed out by few studies (for example, Becheikh et al., 2006; Coombs et al., 1996; Santarelli and Piergiovanni, 1996), indicators have been developed to measure innovation performances based on its outcomes. Compared to survey data, using secondary data in this study is beneficial for its objectiveness. In addition, secondary data is easier to access, and thus requires less time to collect and is easier to use for comparative studies (Saunders et al., 2016, p. 331). Hence, the quantitative part of the study will rely on secondary data.

Generally speaking, the input of innovation refers to resources an organisation allocated to different stages of innovation processes (Adams et al., 2006, p. 27). Accordingly, there will be two constructs to be specified, resources and stages of innovation. Resources may include people, 'physical' and financial resources, ideas and tools, whereas stages may include activities from idea generation, R&D, testing to commercialisation (Hagedoorn and Cloodt, 2003, p. 1368). Studies using 'input data' to measure innovation often focus on financial resources allocated to R&D, i.e. R&D expenditures or R&D expenditures (Flor and Oltra, 2004, p. 324). Flor and Oltra (ibid., p. 325) also pointed to other input indicators for innovation that include (1) existence of formalised R&D departments, (2) participation in external R&D projects, (3) acceptance by publicly-funded innovation programmes, and (4) educational background of staff. However, in terms of this study, having a R&D department can only be quantified as a binary variable, and other indicators are difficult to quantify. As a result, this study will be using R&D expenditures for input indicators.

In terms of output indicators, from the late 1950s onwards, the number of patents became a primary indicator of innovation output (Santarelli and Piergiovanni, 1996, p. 689). However, through the development of measuring innovation, it was noted that using patent counts to

indicate innovation is rather indirect (Coombs et al., 1996, p. 404). As mentioned in Subsection 2.3.1, innovation outcomes are products or services that have reached the market and not all patents can lead to these outcomes. To address this, studies have put effort into developing additional indicators based on patents and also finding alternative indicators to supplement data using patent counts. As a result, an alternative indicator has been proposed, namely 'literature-based innovation output' (see descriptions in later paragraph). According to Becheikh et al. (2006) 18% of the studies in innovation from 1993 to 2003 used patents as measurement, whereas 25% used literature-based indicators. It is also notable that 15% of the studies have combined these two indicators (ibid.). Considering the complexity of defining exploration and exploitation in this part of the study, it may be wise to use a combination of both patent counts and literature-based data on the 'output' side. The following paragraphs will provide more details on the meaning of these two indicators.

Patent counts as an indicator for measuring innovation performance is both acceptable and contradictory (Hagedoorn and Cloodt, 2003, p. 1368). The usefulness of using patent counts in evaluating R&D performance has been proven in many high-tech sectors in developed countries (ibid.). However, it cannot be ignored that the number of patents only represents quantity of invention rather than innovation, and the impacts of different patents is very likely different (Santarelli and Piergiovanni, 1996, p. 690). To address these drawbacks, one should also consider the economic and technological impact of a certain patent. For the economic impact, the indicator of 'innovation based on patents' is developed, which uses additional information requested from patent holders for further information such as how many profits has been made based on each patent (Del Monte and Papagni, 2003; Hidalgo and Molero, 2009). Considering the use of secondary data, this indicator is not suitable for this part of the study. In terms of technological impact, patent citations can be used. This indicator is based on analysis of the number of citations a patent receives and received (Hagedoorn and Cloodt, 2003, p. 1368; Santarelli and Piergiovanni, 1996, p. 691).

For innovation related studies, it is argued that relying only on patent data is not without its limitations (Subsection 9.5.1). Hence, a more direct approach to measure innovation adopted by previous studies is literature-based innovation output indicators. This approach was first adopted by Edwards and Gordon (1984) and used in studies from different regions (for example, Coombs et al. [1996] in UK, Santarelli and Piergiovanni [1996] in Italy, and Flor and Oltra [2004] in Spain). Basically, the use of this indicator is based on technical, trade journals or other professional publications from specific industries (Flor and Oltra, 2004, p. 327).

Specifically, this indicator will be relying on the counting by a researcher in selected journals of editorial 'new product' sections (Coombs et al., 1996, p. 406). To further categorise this indicator, two dimensions of 'type of novelty' and 'degree of complexity' for counting of this measure was introduced in Bain and Kleinknecht (2016). These two dimensions can be used for further justification of different types of innovation in addition to counting. This can be supplementing the data collection of this study. However, using literature-based innovation output indicators can be time consuming. To get more accurate data, two or more researchers are often needed for the coding process of relevant literature. Therefore, it has been considered that literature-based innovation output indicators should be included in the study to some extent. However, it would be impossible to use it as a main source of data at current stage. Taken into consideration these arguments, this study will use patent counts as the main data source and literature-based innovation output indicators as data for the additional validation stage; detailed in Section 6.6.

6.3.2 Measurements of Exploration and Exploitation Using Secondary Data

Previous studies have made several attempts to capture exploration and exploitation with patent data. In these attempts patent citation has been regarded as an important indicator to determine whether a certain patent can be considered as explorative or exploitative. Quintana-Garcia and Benavides-Velasso (2008, p. 498) proposed a patent that has no citation to previous patents can be considered exploration, whereas exploitation is the patent that has citations to prior patents. Similar to this classification, Benner and Tushman (2002, p. 686) provided a more detailed code of identification, with the citation rate of a patent below 40 percent as exploration and above as 40 percent as exploitation.

However, both interpretations of these measures have considered the novelty of a patent to a wider context rather than an organisation itself. Linking back to the original definition, exploration refers to generating outcomes that are new to the organisation, whereas exploitation refers to obtaining outcomes based on existing knowledge of the same organisation. Hence, it would be logical to measure the outcome aspect of exploration by the number of patents that have no self-citation, which indicates that the generation of this R&D outcome is new to the company. Similarly, the outcome aspect of exploitation can be measured by the number of patents that have self-citation, which indicates that this R&D outcome is obtained based on to some extent the patents that are already owned by the organisation. Consequently, ambidexterity is assessed by organisations that (1) have both

types of patents and also (2) how efficient R&D input is transformed into the total amount of these two types of patents (Subsection 4.4.5).

6.3.3 Sector Identification

To ensure sufficient data and get insightful results in this first attempt of using data envelopment to investigate ambidexterity, this study applied some guidelines in selecting the industries. Taking into account information-oriented selection strategies, Flyvbjerg (2006, p. 230) distinguished four basic types of sampling strategy. Here, 'critical cases' aim to obtain information to enable logic deductions and are more suitable for the selection of industries in this study. The reasons are as follows. First, critical cases are suitable for research that has limited time and resources (ibid, p. 231). Second, the strategy of the 'most likely' case is beneficial in the selection, because there has not been a clear indication about the sectors that will definitely have ambidextrous organisations. Therefore, this selection process will need additional criteria to ensure the final sample selected is likely to fulfil the purpose of this part of the study.

Since this part of the study is focused on the stage of R&D in innovation processes, the selection will be considering industries that have a larger proportion of product innovations compared to service and business model innovations. In addition, more criteria have been defined based on the data requirements and purpose of this study to help the selection of cases. The first criterion is regarding outsourced R&D and in-house R&D. Organisations in the selected industry should have relatively strong control of their R&D and innovation activities. This is to better track how certain inputs has converted certain R&D outputs. The second criterion lies in technological intensity. With the focus on product innovation, the selected industry should have a relatively strong emphasis on research and development into new or improved technologies. The third criterion considers the product life-cycle. The average cycle time for researching and developing a technology in the selected industries should be relatively short. This is to ensure that the R&D expenditures in a certain year are transformed into patents within a relatively short period of time. For example, industries, such as the pharmaceutical will not be considered because the development of new products often takes longer. The fourth criterion concerns industrial lifecycle. The sector should at least not be in its decline stage, this is to ensure that organisations in the selected industry are particularly dependent on both exploration and exploitation capabilities. The fifth criterion is about willingness to report innovation and patenting R&D outcomes. This is to make sure there are enough and sufficient output data of R&D to be collected. The last

criterion is accessibility. The access should be relatively easy to gain in selected industry, this will be beneficial for the qualitative study in the later stages of empirical data collection.

With the criteria detailed, the decision has been further made to conduct this study in the context of United Kingdom (UK). The reason for this is in two-fold. First, this doctoral study is UK-based, therefore it may be easier to get access to companies for later studies. Second, as one of the developed countries, companies in it may have as a relatively long history in practicing innovation related activities and managing innovation processes.

In addition, for sector identification, 'Statistical Classification of Economic Activities in the European Community' (NACE Rev.2) has been adopted as the code for classification. Notably, the United Kingdom Standard Industry Classification of Economic Activities (UKSIC) also exists as a code for classification that may be more suitable within the context of the UK. However, the two databases (see Subsection 6.3.5) that this study uses do not provide the option of use UKSIC as a classification code, hence, NACE Rev.2 will be adopted. Moreover, this study has only used primary codes from NACE Rev.2, to increase the number of companies that are included in the study. As a result, the sectors in this study will be:

Sector A) Manufacture of food products (Code: 10) and beverages (Code: 11)

Sector B) Manufacture of computer, electronic and optical products (Code: 26), and manufacture of electrical equipment (Code: 27)

Sector C) Manufacture of motor vehicles, trailers and semi-trailers (Code: 29), and manufacture of other transportation equipment (Code: 30)

Sector D) Manufacture of machinery and equipment (Code: 28)

6.3.4 Data Collection Procedure

To begin with, input data of R&D expenditures were first collected. Patent data was then collected based on the companies that have data available on R&D expenditures. The collection of input data was extracted from two databases, Amadeus and Fame. In total, these two databases provide basic information for the list of companies, including: (1) location, (2) website, (3) registration number, (4) operating revenue, (5) number of employees and (6) R&D expenditures. The data for R&D expenditures was collected according to the calendar years 2014, 2015 and 2016. Data from 2014 was relied on, whereas data from 2015 and 2016 was used as benchmarks for each company. The category of the initial company selection is presented in Table 6.1 with sector B as an example.

Table 6.1 Example of Search Strategy

Search Steps		Step result	Search result
1.	All active companies and companies with unknown situation	3,209,932	3,209,932
2.	Region/Country/region in country: United Kingdom	239,589	226,197
3.	NACE Rev. 2 (Primary codes only): 26 - Manufacture of computer, electronic and optical products, 27 - Manufacture of electrical equipment	33,112	2,156

After the initial selection of the companies, results from the two databases were compared. Companies that only showed up in one of the databases were added to the main data sets and companies with conflicting data recorded in the two databases were taken note of. In this case, for the companies that have different data recorded in the two databases, additional searches were conducted; this included check in the annual reports (if available) and other official sources. If the conflict of data reported was remained unsolved, this study go along with data recorded in the Fame database. This is because it is a specialised database in the UK context.

Patent data was first collected from the Amadeus database, including basic information, such as: (1) title, (2) publication date, and (3) application number. After the collection in this database, there was an evaluation to assess whether the initial patent data was sufficient enough to capture innovation outcomes. Here, attention was paid to companies that have reported their R&D expenditures in the database, especially for those companies that have a high R&D expenditure but only small number of patents. In addition, companies that have reported input data but without output data, have been checked using other source, to clarify the reason. For example, through their website or with the name of the company as keywords in Google. These checks were to ensure no patents have been missed out in the databases.

After data for all sampled companies was collected, each patent was searched for in the ‘Patents Publication Enquiry’ from the Intellectual Property Office website. These searches covered detailed information about its publication number. Furthermore, companies whose patents may not have been reported in the Amadeus database have been searched for in the ‘Espacenet’ database with the company name as ‘applicant’. After these searches and classifications, companies that were still missing output data have been removed. Backwards and forwards citations of every patents have been recorded. Patents that contained self-citation were classified and counted under ‘exploitation’, without self-citation under ‘exploration’. All the patent data were cross-checked with the ‘Google Patent’ database.

6.3.5 Data Sampling and Preparation

To improve accuracy and remove duplications in patent data, an additional exanimation was conducted to determine whether a patent should be included or excluded. For inclusion, first, patents that were pending were included, this is because the pending patents are already considered as outcomes of the R&D processes and these patents may just be waiting for the legal processes to come through. Additionally, pending patents were cross-checked with later granted patents and ceased patents to avoid duplication in the database. Second, patents that have the same title but covered different content in the document were examined. After making sure these are different patents, both were included to their corresponding organisations.

For exclusion, first, patents that had statues of 'ceased' or 'abandon' were excluded. The same applied to the applications that were withdrawn. This is because these patents are not considered as valid outcomes of R&D processes. Second, same patents that have different identification number were regarded as duplicated and removed as the database has often recorded these patents as different patents. Table 6.2 presents a summary of these inclusion and exclusion criteria with examples for each criterion.

Table 6.2 Patents Sampling

Situation	Treatment	Examples
Patents that have the statues of 'Pending'	Included, but cross-checked to avoid duplication	EP3091503(A1); US20170015408(A1)
Patents that have the statues of 'Ceased'	Excluded	EP3106385(A1)
'Application withdraw, taken to be withdrawn or refused after publication under section 16(1)'	Excluded	US2014248520(A1); US2014103667(A1)
Patents that have the same title but may cover different content in the document	Included, with cross examination	US2016121947(A1): Working Machine US2016121721(A1): working Machine
Same patent having different identification number	Duplication excluded	WO2014170635(A1) US20160083105(A1)

Taking into consideration the fact that sample organisations should all be UK-based, this study has conducted another step of checking the data. There are few organisations in the sample that are multi-national corporations. In the searching steps, R&D expenditures were

collected for the operations of these organisations narrowed to UK-based. However, some patent data were recorded under these UK-based subsidiaries are actually belonging to the overall corporation. Using a random organisation as an example, the data collection will take 'Sony Europe Limited' as the sample organisation rather than 'Sony Corporation'. Therefore, patents that belongs to 'Sony Corporation' were removed. Nevertheless, when it comes to classification, patents that belongs to 'Sony Europe Limited' that have citations to patents belonging to Sony Corporation will still be counted as having self-citations, i.e. exploitation.

6.3.6 Descriptive Statistics

Following the procedure and additional data preparation, the samples in this part of the study were finalised. Table 6.3 presents the final numbers of organisations and patent counts that are included in the sample. In the process, Sector A has been removed from the sample, because the number of organisations reporting data is only 8 (see Subsection 6.2.5). In contrast, Sector C has 13 companies, which is still higher than the lowest limits of nine. Therefore, sector A is removed from the sample and companies from Sector B, C and D were the samples for the analysis.

Table 6.3 Final Sample Size

Sectors	Data Available (no. companies)	Final Sample size (no. companies)	Total patent counts
B: Computer, electronic, optical and electrical	110	63	643
C: Transportation equipment	23	13	323
D: Machinery and equipment	61	36	403

With the data for the three sample sectors collected, Table 6.4 presents the descriptive statistics of the final sample, including the mean and standard deviation for R&D expenditures, 'exploration' and 'exploitation. All three sectors have shown differences in terms of the descriptive statistics, which reflects different features of the context. Hence, it is suggested that data envelopment analysis should be conducted with the organisations within the same sector rather than mixing all the sample companies up. This should ensure accuracy for efficiency score and capability frontier. One more thing to note in the sample is that organisations are coded based on a descending order of their R&D expenditures. This means that organisation B1 has the largest number of R&D expenditures in Sector B and B63 the lowest (B1>B2>…>B63). This will be useful in the discussion of Subsection 6.5.1.

Table 6.4 Descriptive Statistics

Item	Total (Count)	Mean	SD
Sector B (N=63)			
R&D_E	269,298	4,274.57	11469.48
Exploration	346	5	6.75
Exploitation	290	5	9.03
Sector C (N=13)			
R&D_E	1,759,408	135,339.08	378100.94
Exploration	209	16	19.19
Exploitation	114	9	13.49
Sector D (N=36)			
R&D_E	166,582	4,627.28	10902.88
Exploration	227	6	7.99
Exploitation	175	3	5.60
Total (N=112)			
R&D_E	2,195,288	19600.79	131685.20
Exploration	782	6.98	9.82
Exploitation	579	5.17	8.77

6.4 Results of Data Envelopment Analysis

6.4.1 Overview of Results

The analysis has been conducted using the MaxDEA software. The software has been used to run the two data envelopment analysis models (BCC input and BCC output) and to provide results on scores, benchmarks, and projection for each decision-making unit (DMU). The full results of the analysis are presented in Appendix V. The overall results has provided the following information: (1) two sets of efficiency scores based on both input- and output-orientated model, (2) two sets of benchmarks based on both input- and output-orientated model, (3) a projection value of R&D expenditure based on input- orientated model and (4) projection values for both innovation output based on output- orientated model. The projection value is an indication of the target value that each DMU has to achieve in order to become efficient. Further interpretation of the results will be present in the following sections.

6.4.2 Meaning of Results

As discussed previously, the efficiency score is calculated for each decision-making unit (DMU) within their sector. Based on the table, DMUs that have the score of 1 will be identified as efficient in the analysis. Accordingly, 6 efficient units are identified in Sector B: B19, B2, B5, B57, B62 and B63; 6 in Sector C: C13, C2, C5, C8, C12 and C11; and 7 in

Sector D: D1, D10, D2, D25, D32, D34 and D36. It is also shown in the results that all the efficient units identified in the analysis have consistently this score in the input- and output-orientation model. This has been noted in DEA studies that changes in input and output orientated model will only change the projection value for inefficient units on efficient units but not affecting the identification of efficient units (Charnes et al., 1994 and Copper et al., 2007). Moreover, in the results of DEA, the 'best performing' DMUs create an envelopment surface, also known as efficiency frontier. The level of inefficiency of other DMUs is measured against this frontier. In this study, analysis for DMUs in each sector is run differently, hence, there will be one unique frontier for each of the three sectors.

The DMUs that have scores lower than 1 are considered to be inefficient in their given context. Notably, the purpose of the score in the results is not to give ranking to all DMUs, it is instead suggestions for the degree of inefficiency (i.e. lack of capability comparing to their benchmarks). Considering the fact that the results indicate an efficiency frontier rather than an efficiency point, inefficient DMUs will have different ways to move towards the frontier. Consequently, for every inefficient DMUs a benchmark set (in some case it is been called reference set) has been provided and the score is calculated based on the benchmark set rather than based on the whole sample.

Hence, the results should be considered more as benchmarking rather than ranking, because for each inefficient DMUs the benchmark set may be different. Taken into account how the efficiency scores are calculated, there are also differences in the scores between the input- and output-orientated models for inefficient units. Generally, the input-orientated model is to contracts the inputs as far as possible while maintaining the same level of outputs. Whereas output-orientated model aims at expanding the outputs as far as possible while controlling the inputs (Charnes et al., 1994). Therefore, although the efficiency frontier of DMUs is unchanged, there will be a different benchmark set for inefficient DMUs, because the suggested way for each DMU to move towards the frontier may be different.

The projection value is reflected in how inefficient DMUs can move towards the efficiency frontier. In the input-orientated model, the projection value indicates the level of input each DMUs has to reduce while maintaining the same level of outputs, whereas in the output orientated model the projection value suggests the level of output that each DMU has to reach without increasing the input. For DMUs that have only one other DMU as benchmark set, the optimised level of either input or output will totally be the same as the benchmark set. In other cases, the projection value will depend on all DMUs in the benchmark set, with

the value ‘lambda’ indicating the percentage each DMU weight in the set. For example, for the benchmark set of B1 in input orientated model, B57 weigh 40% and B63 weigh 60% in the reference set. The projection value for B1 here is calculated by 40% times the original input value from B57 plus 60% times the original input value from B63.

Overall, the results have provided a relative position for every DMUs within their sector, no matter being efficient and, on the frontier or not efficient, but also, they have pathways towards the frontier. It is shown that scores can be significantly different for an inefficient DMU between input- and output-orientated models. This will be discussed further in the next section.

6.5 Discussion of Results

6.5.1 Identifying Ambidextrous Organisations

Reflecting on the discussion in the previous sections, ambidextrous organisations were defined as organisations that met: (1) both exploration and exploitation criteria and (2) the ability to maintain efficiency according to both criteria. Based on the sampling process and the logic of DEA, all the DMUs that are in the analysis have both patents with and without self-citation. Therefore, they are considered to have both exploration and exploitation capabilities, meeting the first condition. Moreover, all the DMUs that have the efficiency score of 1 are identified as efficient in transforming input to both outputs. Hence, they can be regarded as able to maintain efficiency in both exploration and exploitation related processes or activities, meeting the second condition. As a result, DMUs that have an efficient score of 1 is identified as ambidextrous organisations in this part of the study. For discussion purposes, they will be sometimes referred to as ambidextrous organisations in the later part of the thesis.

After the identification of ambidextrous organisations, it is possible to see how three sectors have shown differences in terms of ambidexterity performance to some extent. Table 6.5 presents some further statistics reporting the average efficiency score from both the input- and output-model, and the percentage of organisations in the sample that are considered ambidextrous.

Table 6.5 Ambidexterity Performance of the Three Sectors

Sector	Average Efficiency Score (Input model)	Average Efficiency Score (output model)	Percentage
B	0.19	0.35	9.37%
C	0.56	0.70	46.15%
D	0.37	0.54	19.43%

In Table 6.5, there are two main points worth noting. First, from an overall performance point of view, sector C has the best performance and sector D is better than sector B in terms of average efficiency scores in both the input- and output-oriented models (C >D >B). This best performance of Sector C is similar to what the statistics of average R&D expenditure within the sector suggested, of which Sector C has shown the largest amount (see Table 6.5). However, this does not mean that a higher actual amount of input and output will lead to overall better performance. This point is also support by comparing sector B and D. It is notable that although both sectors share similar features in descriptive statistics, the performance of sector D is better than sector B. Therefore, this study argues not to draw conclusions relating descriptive statistics to the ambidextrous performance of the three sectors because factors, such as market demands and different R&D structures of the sector, may affect this relationship. Since understanding performance of sectors is not the aim of this study, this study will not further elaborate on this point.

Second, by the comparison of performance based on input- and output-oriented models, it is shown that for all three sectors, the average efficiency scores based on the output-oriented model are higher. This may suggest that for organisations in all three sectors, the focus should be on increasing the outcomes from R&D processes, because it is a more efficient way moving towards the frontier. The lower average efficiency scores based on the input-oriented model means that organisations in these sectors should not yet emphasise on cutting cost in R&D. This possible tendency needs to be cross-checked with the qualitative part of this study.

With regard to the relationship between (1) efficiency scores and the actual amount of input, (2) efficiency scores and total amount of patents, and (3) efficiency scores, and exploration and exploitation, there are no signs of a significant linear relationship between the actual amount of inputs and outputs with ambidexterity (for distribution charts for all three sectors, see Appendix VI). This is aligned with the conceptualisation of ambidexterity from a capability-based approach that organisations will not be more ambidextrous by simply aiming at increasing outputs or decreasing inputs. This means that ambidexterity does not

necessarily mean high levels of input or output as the distribution of efficient organisations is relativity even across different levels of inputs and outputs. As indicated in Subsection 6.3.7, organisations are coded on a descending order based on their R&D expenditures (the actual amount of input). This means that ambidextrous organisations identified such as B62, B63, C12, C13, D34, D36 all have a low amount of input comparing to other organisations in their sectors. This is to say using DEA as the method, ambidextrous organisations are identified regardless of the actual amount of input or output of the R&D processes. Hence, it would be beneficial to see if not linear, what is the relation between ambidexterity and the actual amount of input and outputs.

To be more specific, first, regarding the relationship between ambidexterity and the actual amount of R&D expenditure, in Sectors B and C, the organisation that has the highest level of R&D expenditures is not identified as ambidextrous. This is reasonable considering it has been proven by previous studies that a high level of R&D expenditures does not guarantee a high volume of patents (Baumann and Kritikos, 2016; Hall and Bagchi-sen, 2002). Hence, it is arguable that blindly increasing investment in R&D or innovation processes may not be a wise move towards ambidexterity, because this does not mean that organisations will be more efficient in converting this increased amount in R&D expenditures into patents. In addition, organisations with low amount of inputs can also be ambidextrous. For example, B63 has the lowest amount of R&D expenditures in the sector but is also ambidextrous. This suggests that ambidexterity is more about internal processes that concerns converting inputs into outputs. This needs to be examined in the qualitative part of the study.

Second, in terms of the actual amount of output, the results overall demonstrate that organisations with the highest level of output in all three sectors are identified as ambidextrous. Although patents are the only output factor used in this study, this result still pointes to the usefulness of outcome-based identification of ambidexterity. However, there are also ambidextrous organisations identified with a relatively low amount of patents. In outcome-based approaches to identify ambidextrous (Subsection 4.4.5), organisations with a low volume of output will be considered to have poor performance and not being identified as ambidextrous. Differently, using this capability-based approach through DEA, some organisations that are relatively underperforming in terms of generating patents can still considered being ambidextrous. Hence, using the capability-based approach in this study, ambidexterity is not about the ‘higher the better’, rather, it would be more about evaluation of input-output relationships and possibly how efficient the organisation is managing R&D processes.

Third, looking at ambidexterity and the 'count' of exploration and exploitation, there are no significant differences in the relationship between ambidexterity and the amount of either exploration or exploitation. Similar to the discussion on total patent counts in the previous paragraph, there are organisations with a relative low amount of either exploration or exploitation that has been identified as ambidextrous. To see whether there are any differences in the importance of exploration and exploitation to ambidexterity, Table 6.7 presents the percentage of exploration and exploitation based on total patent counts from all 18 ambidextrous organisations from the three sectors. According to Table 6.6, there is no pattern showing a certain percentage of exploration and exploitation in ambidextrous organisations. This means that some may have high exploration and low exploitation (e.g. B19, C8 and D25), or the other way around (e.g. B5, C5 and D36). This is to say that assuming the argument 'ambidextrous is achieved through balancing exploration and exploitation' is correct (Subsection 3.4.3), this 'balance to achieve' may be different for each organisation. By definition of ambidexterity in management studies, exploration and exploitation should be considered equally important for achieving ambidextrous; this also need to be further investigated in the qualitative part of this study.

Table 6.6 Ambidexterity, Exploration and Exploitation

DMU Code	Percentage of Exploration	Percentage of Exploitation
B2	44.0%	56%
B5	29.6%	71.4%
B19	91.4%	8.6%
B57	25.2%	74.8%
B62	87.5	12.5%
B63	75%	25%
C2	43.5%	56.5%
C5	31.0%	69%
C8	96.7%	3.3%
C12	33.3%	66.7%
C13	75%	25%
D1	57.4%	42.6%
D2	69.1%	31.9%
D10	41.1%	58.9%
D25	91.7%	8.3%
D32	57.1%	42.9%
D34	83.3%	16.7%
D36	33.3%	66.7%

6.5.2 Becoming Ambidextrous

Without looking into the detail processes and management of innovation, the results have provided an indication for how each organisation in the study can move towards the frontier

and become ambidextrous. Considering the logic behind DEA, there is not a universal way for each organisation to become ambidextrous. This is because of the differences between their own benchmark set (Subsection 6.4.2). For changes in the input, the proposed way is that organisations can reduce the amount of R&D expenditures while maintaining the level of innovation output to become ambidextrous. For changes in output, since this study take patents as an indicator, the suggestion is better to be viewed as a 'relative percentage' rather than as an absolute volume. Take B6 as an example, according to the projection value given by Table 6.6, B6 can achieve ambidexterity by reaching the level of exploration at around 29 and exploitation around 26. Considering the original level of output for B6 is exploration at 19 and exploitation at 17, to become ambidextrous, B6 has to increase its exploration and exploitation both by approximately 65%. This method can be applied to every inefficient organisation in terms of R&D capability defined here, and a pathway towards the frontier can be calculated.

Also, as mentioned in Subsection 6.4.2, the input- and output-oriented model provided two different ways of thinking for becoming ambidextrous. For some organisations, considering the original value for the input level, it may be a situation that one of the ways is not suitable. Take B1 who has the highest amount of input as an example. Taking an input-oriented approach will require the reduction of R&D expenditures by 84,716,400 Euro. This is basically impossible considering the original level of R&D expenditures. Hence, this study suggests that without looking into detailed managerial practices, it is not feasible to understand the decision-making about pursuing ambidexterity, with the premise that it is a criterion that is considered by organisations. Either the input- or output-oriented approach for becoming ambidextrous will allow organisations moving towards the frontier, related to finding the right benchmark set.

These discussions suggested how ambidextrous organisations should be viewed differently considering both resource allocation and outcomes. However, without looking in more detail into internal processes of organisations, all points made in this section are preliminary. In addition, suggestions about how to become ambidextrous based on DEA results are mainly theoretical rather than practical. This is why none of the names of the organisations in the sample have been revealed. Since this is the first attempt to use DEA in identifying ambidextrous organisations, the results from the analysis need further validation.

6.6 Additional Validation

This section will present an additional validation study to see how reliable the outcomes of DEA are. Here, validation means comparing the results from DEA that are based on patent data with results from analysis using alternative data sources. Details of this validation study will be presented in the following subsections, starting with its purpose and ending with the outcomes.

6.6.1 Purpose of Validation

As discussed in the previous sections, taking a capability approach to identify ambidextrous organisations using data envelopment analysis has provide some insight to understand and identify ambidextrous organisations. Table 6.7 summarised all the key findings discussed in previous sections. For the purpose of comparison of the findings from data envelopment analysis with findings from other methods in this doctoral study, the findings from DEA are labelled as **DEA1-DEA6**.

Table 6.7 Key Findings of DEA

Key findings	Discussed in text
DEA1: multiple organisations are identified as ambidextrous with efficiency score of 1 within each sector	Subsection 6.4.2
DEA2: organisations with relative high level of R&D expenditure are not necessarily being ambidextrous	Subsection 6.5.1
DEA3: ambidextrous organisations can also be identified in the set of organisations with a low volume of patents	Subsection 6.5.1
DEA4: exploration and exploitation does not show significant differences for achieving ambidexterity	Subsection 6.5.1
DEA5: pathways towards becoming ambidextrous is different for each organisation	Subsection 6.5.2
DEA6: input- and output-oriented model provides two different pathways towards becoming ambidextrous. Organisations need to consider their own situation when selecting between the two pathways.	Subsection 6.5.2

According to Table 6.7, the key findings are dependent on **DEA1**. However, considering the basic logic from data envelopment analysis, this method does not provide a test or validation to answer questions. Unlike other regression-based analysis, DEA used here relied heavily on the conceptualisation of key concepts of exploration, exploitation and ambidextrous organisations. This is to say that DEA provides an indication of which organisation with a score of 1 within their sectors but does not prove the point that organisations with an efficiency score of 1 are ambidextrous. Hence, to ensure validity and reliability of the

findings from this empirical part of the doctoral study, additional validation with alternative methods or data sources is needed. Here, the main purpose of the additional validation is verifying the ambidextrous organisations identified by data envelopment analysis, and sequentially, examining all the key findings listed in Table 6.8.

6.6.2 Propositional Logic and Method

This study has applied propositional logic based on statistical analysis, specifically in terms of type I and type II errors to carry out the validation. The statement to be validated is 'organisations that have an efficiency score of 1 are ambidextrous'. Based on this, within the samples, organisations can be either 'ambidextrous' or 'not ambidextrous', and the efficiency score can be either equal to 1 or less than 1. Table 6.8 presents four possible circumstances that may occur. In order to verify the given statement, the validation method should be seeking to confirm the two 'correct inference' circumstances. In this case, they are 'ambidextrous organisations efficiency score =1' or 'not ambidextrous organisations efficiency score <1'. Considering time and resource can be constrains, this study will provide additional evidence to 'ambidextrous organisations efficiency score =1', because it requires only additional data collection for the 18 ambidextrous organisations identified.

Table 6.8 Validation Logic

	Ambidextrous	**Not Ambidextrous**
Efficiency Score =1	Correct Inference	Type II Errors
Efficiency <1	Type I Errors	Correct Inference

To accomplish this validation, the 18 organisations with an efficiency score equal to 1 are looked at. Additional secondary data regarding these companies are collected and with reference to the way of identifying ambidextrous organisations in previous literature. Additional analysis is also conducted to see whether these organisations are actually being identified as ambidextrous (examples of how previous studies have identified ambidextrous organisations can be found in Table 4.5). By doing so, this validation is aiming at minimising Type II errors. However, if the possibility of Type II errors occurring is minimised, then the possibility of Type I occurring will be higher. In this case, this means that there may be some organisations with their efficiency score less than one being ambidextrous. This study has noted this possibility and will discuss the consequence in the Subsection 9.5.1 about limitations of this study.

6.6.3 Data Collection and Analysis Procedure

The additional data collection for the validation will follow the basic idea of literature-based innovation output. As discussed in Subsection 6.3.2, literature-based innovation output can be an alternative data source to patents with the benefit of a 'direct capture' of innovation performance. However, the data collection in this part of the study will focus more on content rather than the counting of innovation output. For example, for a given company, if there are 3 articles reporting new product announcements, in a typical literature-based innovation output indicator collection, this counts as 3 outputs. However, here the focus will be on whether the content of these articles reflect how innovative that particular company is.

Overall, the data for additional validation included data about innovativeness and financial performance of the organisations. Data about innovativeness was collected from the year 2014-2017, mainly from three sources: (1) companies' official documents, including annual reports (if available) and official websites that reporting anything related to innovation, (2) Google search engine, with an emphasis on 'press releases' and relevant 'innovation awards', and (3) Nexis database, which includes archives of professional journals and newspapers. The emphasis here is mainly on 'new product announcement' and 'new product introduction'.

In addition, financial data of the selected companies was collected through the FAME database, with the indictors of return-on-capital-employed (ROCE) and profit margin in the year 2014. ROCE was calculated as dividing net profit by the employed capital, whereas profit margin was calculated as net income divide by revenue (Weetman, 2009, pp. 339-340). These indicators were chosen, because they are both useful indicators for measuring the management financial performance. Here, ROCE provided an overview of the financial performance with profit margin contains further information on profitability of the organisations (ibid., p. 346).

After determining and collecting data, all the required data on innovativeness was stored in the format of text and the analysis was based on finding 'evidence of innovativeness'. All relevant evidence of innovativeness is picked up and synthesised based on its similarity. The evidence of innovativeness together with the additional financial data will be presented in the next section.

6.6.4 Results and Discussion

Table 6.9 presents an overview of the results from the validation. Note here that information that may reveal the names of organisations in this study is removed. According to the table, evidence of innovativeness for each company may cover three aspects. Specifically, first, from innovation-related content in statements from a company's official website or annual reports, it is possible to suggest whether the selected organisation emphases innovation. This may sometimes reflect in their vision or innovative culture. Second, new product announcements are the most common source used in literature-based innovation output indicators. Additionally, new product displayed in events is included as it is also considered a direct outcome of R&D. These two indicators directly reflect innovation outcomes from the organisations. Third, innovation awards are sometimes tied to a certain product or project. In other occasion they are awarded for the overall innovation performance of an organisation. Hence, this is taken as a good indication of how innovative an organisation is.

Table 6.9 Summary of Validation Results

DMU Code	ROCE (%)	Margin (%)	Evidence of Innovativeness
B2	23.05	27.11	1) Company website mentioning innovation is the core of their business 2) New product announcement in 2015 3) Multiple innovation awards
B5	9.06	4.83	1) Multiple new product announcement in press release 2) Annual report on innovation indicating the main focus of the organisation
B19	77.05	1.98	1) Shortlisted for multiple innovation related awards 2) Multiple New products announcements through the years
B57	7.81	7.22	1) Company website mentioning their commitment to innovation 2) 2 new product announcements through the years 3) Innovation related award won at 2014
B62	3.19	0.9	1) Company website mentioning the recognition of the organisation in the industry for innovation. Also indicating their leadership in technology. 2) Multiple innovation related awards 3) New product display during event in 2016
B63	2.16	0.88	1) Company website reporting innovation related awards 2) Multiple new product announcement
C2	9.11	4.68	1) Company website indicating innovation lies in the key strategies of the organisation. 2) Multiple new product announcement 3) Multiple innovation related awards
C5	29.17	4.5	1) Company website mentioning innovation as one key mission of the organisation. 2) New product announcement in press release

DMU Code	ROCE (%)	Margin (%)	Evidence of Innovativeness
C8	18.85	5.72	1) Company website mentioning innovation as the key to competitiveness of the organisation. 2) Innovation related awards won in 2016
C12	20.86	8.76	1) Company website mentioning the importance of motivating staff to continuously pursue innovation. 2) Multiple new product announcements.
C13	23.14	6.51	1) Company website mentioning their commitment to innovation 2) New product demonstration during event in 2015.
D1	39.03	13.25	1) Company website mentioned innovation is the key to their success in the business aspects. 2) New product announcement in 2015 3) Innovation related award won in 2015
D2	16.16	4.85	1) Company website mentioning their commitment to invest in cutting-edge technology. 2) 12 New Product announcement through the years
D10	20.49	13.47	1) Company website indicated their foci and investments in innovation 2) New product announcement in 2016
D25	9.75	16.15	1) Company website mentioned their accomplishments in innovation and their commitment to continue undertaking innovation 2) New product announcement in 2016
D32	12.99	6.76	1) Company website mentioned their success in innovation and their commitment to innovation in the future. 2) new product announcement in 2016
D34	18.34	8.01	1) New product display during event in 2015 2) New product announcement in 2017
D36	38.66	16.1	1) innovation related award won in 2016 2) New product display during event in 2015

As shown in Table 6.9, all organisations in the sample have shown evidence of innovativeness for at least two out of three aspects. It is clear that companies' websites have served as a main source of information. Nevertheless, multiple sources of evidence of innovativeness are found for every organisation. In the results presented, some organisations have mentioned how innovation has been the focal point of their business and helped them to maintain competitiveness (cases in point are B62, C2 and D2). Similarly, other organisations are expressing their commitment and willingness of pursuing innovation. Hence, it is fair to say that based on the information from the company websites, innovativeness seems to be a key element for the organisations in the sample of this validation.

In addition to this 'self-reported evidence' on innovativeness, innovation awards and new product announcement have provided support for the outcomes of innovation in some organisations. Only one out of 18 organisations did not announce any new product through the selected period of time (C8). However, this organisation has won an innovation award and that this award is technology related. This has proven that the outcome of R&D for C8 is recognised. It may be this technology has not yet reached the commercialisation stage in the given time period. Besides C8, the new product announcements reported by the other 17 organisations have provided direct support for their innovativeness. Combining the reporting at companies' websites and their new product announcements, this validation provides evidence supporting that the 18 organisations are innovative.

In terms of financial indicators, all organisations have shown positive figure for the two selected indicators. This demonstrates the profitability of these 18 organisations. Although it is hard to link this overall good financial performance of the 18 organisations with their innovativeness, the results can still be considered as meeting the approaches that previous studies used to identify ambidextrous organisations. These approaches identify organisations that are innovativeness and also have good finical performance as ambidextrous (e.g. Cantarello et al., 2012, p. 35; Hotho and Champion, 2010, p. 39). Hence, the additional evidence supports the results from DEA.

Linking back to the finding **DEA 3** (Table 6.7), it may be beneficial to discuss the results for organisations within the 18 that have relatively smaller quantity of patents. Without precise counts on how many new products announcements an indicated organisation had, it is hard to compare the level of innovativeness between organisations with a low number of patents and a higher number of patents. Regarding financial performance, although some organisations (B62 and B63) who have less patents do have a relatively poorly performance compared to other organisations in their sector, their ratios are still positive. This performance may affect the identification of these two organisations as ambidextrous. Nevertheless, this study argues that they should still be considered ambidextrous as long as they are profitable through the selected period.

Overall, the results from the validation have to some extent supported that the 18 companies identified by data envelopment analysis can also be regarded ambidextrous by an additional approach. More specifically, the results have indicated that all 18 companies have multiple sources of evidence for innovativeness from literature-based innovation output indicators. Furthermore, it also demonstrates their ability of to maintain profitable using financial

indicators. Hence, these results indicate that the purpose of additional validation is met, which provides evidence to strength the key findings from the initial discussions based on results from DEA (Table 6.8).

6.7 Summary of Findings

Supported by the analysis of additional data, results from data envelopment analysis were validated, and demonstrated its usefulness as a method of identifying ambidextrous organisations. Taking exploration and exploitation as evaluation criteria, the outcome of this part of the study identifies organisations with an efficiency score of 1 as being ambidextrous. Also, the results have provided a benchmark and pathways to move towards the frontier for inefficient organisations (DEA score lower than 1) in their specific sectors. Table 6.10 summarises the key findings with indications of how each finding is validated. These findings can not only be a useful first step to use capability-based approach to study ambidexterity, but also provide support to the qualitative parts of this doctoral study

Table 6.10 Validating of Key Findings

Key findings	Method of Validation	Outcome
DEA1: Multiple organisations are identified as ambidextrous with efficiency score of 1 within each sector	· A different conceptualisation of ambidexterity · Logic of DEA · Validation with different data source	Validated with the additional data source (Subsection 6.6.4)
DEA2: Organisations with relative high level of R&D expenditure are not necessarily being ambidextrous	· Cross-check with literature	No evidence found
DEA3: Ambidextrous organisations can also be identified in the set of organisations with a low volume of patents	· Validation with different data source	Validated with the additional data source (Subsection 6.6.4)
DEA4: Exploration and exploitation does not show significant differences for achieving ambidexterity	· Cross check with literature	This finding is aligned with previous literature, that organisations must have both to be ambidextrous (Subsection 3.4.3)
DEA5: Pathways towards becoming ambidextrous is different for each organisation	· Logic of DEA	As indicated by the logic of DEA (Subsection 6.5.2)

DEA6: Input- and output-oriented model provides two different pathways towards becoming ambidextrous. Organisations need to consider their own situation when selecting between the two pathways.	·	Additional research method	Amalgamating of findings will be shown in Chapter 8 (Subsection 8.2.3)

6.7.1 Understanding Ambidexterity

The way this study identifies ambidextrous organisations may be beneficial in the following aspects. First, it is able to identify ambidextrous organisations that have a lower level of input or output volume. These organisations with low level of actual volume of output will be left out if outcomes of R&D were only used. Considering the impact of size and scale of innovation, this approach emphasises more on efficiency in managing R&D processes. Second, this approach also provides a relative benchmark to the frontier for every organisation in the analysis and possible target for each organisation to achieve efficiency by managing R&D expenditures. This may be more realistic than outcome-based approaches in some circumstances, since each organisation is given a specific benchmark set (Subsection 6.4.2).

By defining exploration and exploitation as criteria, and using them in data envelopment analysis (DEA), the quantitative part of this study has provided insight to the first research question of "*How to identify organisations that manage exploration and exploitation efficiently?*" To this purpose, it has followed a re-conceptualisation to ambidexterity (Subsection 4.4.5) and proposed a valid method to identify ambidextrous organisations without looking into the actual processes within organisations. Based on the results, DEA serves a useful tool of using the two criteria to identify what has been called ambidextrous organisation in the literature.

As discussed in the previous sections, this way of identifying ambidextrous organisations is arguably more comprehensive than the 'outcome-based' approaches that have been commonly used in previous literature. However, this part of the study does not provide further insight into how useful this evaluation is. In other words, the outcomes from this part of the study only make sense of exploration and exploitation as criteria, which is still based on outcomes of certain activities or processes. The actual practical treatment for both and

also how this evaluation may influence on-going decision making still needs to be investigated in the following qualitative part of this study.

6.7.2 Linking with the Qualitative Part of Study

Linking with the proceeding qualitative part of this doctoral study, using data envelopment analysis (DEA) as the method for analysis is contributing to the following aspects. As stated in the previous subsection, internal innovation processes of organisations still need to be related to this quantitative part of the study. This means that the actual practices for innovation in organisations still need to be linked with their benchmarked performance. Hence, sampling in the latter parts of the study will be linked to the performance of 112 companies in this part of the study (see Table 6.6 for their scores in DEA). One or more companies from the 112 will be selected for further investigation to the purpose of linking managerial practice with the outcome of the performance evaluation. In addition, the key findings of this part of the study will be compared and contrasted with the findings from the later qualitative parts of the study. Here, the aim is to provide a more comprehensive contribution to knowledge. More details of how different parts of this study are amalgamated is found in Chapter 8.

6.8 Summary of Chapter 6

This chapter presented the quantitative part of this study based on data envelopment analysis (DEA). Linking to the overview presented in Section 5.6, this chapter describe the detailed design of DEA that includes model selection, data collection and data analysis. Results and findings from DEA were validated through additional data and different ways of measuring ambidextrous organisations. The findings presented in this chapter contribute to the overall research aim and addressed the first research question about using the dichotomy of exploration and exploitation as performance criteria. The results in this chapter also provide a sampling base for the qualitative aspect of this study, which will be presented in the next chapter. Some key points discussed in this chapter are as follows:

- The research model used in this study focused on R&D; both input- and output-oriented models are included in the analysis.
- R&D expenditure is selected as input data and patent counts selected as output data. Exploration and exploitation are defined as capability, referring to organisations' ability

to turn input into outputs. Exploration is measured by count of patents without self-citation and exploitation is measured by count of patents with self-citation.

- Ambidextrous organisations were identified based on the results with the decision-making units that have an efficiency score of 1. For organisations that are not identified as ambidextrous, the results have also provided pathways for them to become ambidextrous, through either decreasing inputs or increasing outputs.
- The findings based on DEA are validated through additional data of literature-based innovation output indicators and financial indicators. The ambidextrous organisations identified in DEA have shown the ability of being innovative and profitable, fitting proceeding classifications of ambidextrous organisations by other studies.

Chapter 7 Exploration and Exploitation in Practice: The Qualitative Part of Study

7.1 Introduction

The aim of this chapter is to present the qualitative part of the empirical study that focuses on the internal processes of organisations. This includes the detailed design, results, and discussion of findings from both the focus group and interviews. Since the purpose of the qualitative part of the study is to examine the use of the dichotomy of exploration and exploitation in practices of innovation management, Section 7.2 first discusses how the notion is treated according to **Research Framework 2**. Section 7.3 then elaborates on the detailed design of the focus group. This includes its design, themes, moderation, sampling and data collection. Section 7.4 covers how data of the focus group was analysed. Based on this, Section 7.5 will show the results from the focus group and the key findings derived from the results. Section 7.6 moves on to the design of interviews, with its result presented in Section 7.7. This chapter ends with a summary of findings from both methods.

7.2 Exploration and Exploitation in Practice

As mentioned in Subsection 5.4.3, the purpose of the qualitative part of this study is (1) to understand the impact of exploration and exploitation on ongoing decision-making, and (2) to examine whether this dichotomy is used in practice. Before presenting the detailed designs for the qualitative part of the empirical inquiry, this section will first discuss how this study views exploration and exploitation in investigating the internal innovation processes of organisations.

7.2.1 No Pre-set Definitions

With regard to conceptualising exploration and exploitation, the qualitative study will not define the terms prior to the data collection. This can be considered as an attempt for this study to minimise the influence of its outcomes being a 'Gettier problem' (Subsection 2.4.2). Looking internal processes of organisations, it is still not clear what can be defined as exploration and exploitation. Differences in definition for exploration and exploitation exist, particularly whether these constructs should be defined as activities, processes or strategies (Subsection 3.7.2). Focusing on either one of these definitions may limit this study in terms of its purpose to investigate the application of the dichotomy within organisations. Thus, the findings of the qualitative study may be based on one or two streams of evidence (viewing exploration and exploitation based on a pre-set definition and ignoring other possibilities), and thus turn into 'justified true belief'.

Hence, **Research Framework 2** (Subsection 4.4.6) will guide the qualitative part of this study with it indicating what and how internal innovation processes or systems to investigate but without specific definition to the dichotomy. More specifically, the qualitative investigation will focus on: (1) strategy formation, (2) portfolio management, (3) resource allocation, and (4) recurrent processes in innovation (see Figure 4.2). In terms of this study, the themes and questions for the focus groups and interviews will be developed based on these aspects in **Research Framework 2**. Detailed discussion on themes and questions developed for the focus groups and interviews will be presented in Subsections 7.3.2 and 7.6.2.

7.2.2 Postulations of March (1991) in Practice

In addition to the guide from **Research Framework 2**, the six postulations from March (1991) will be focused on (Subsection 3.3.4). Doing so enables the search for direct evidence for these postulations and contributes to the challenge of the dichotomy of exploration and exploitation. Referring back to Table 3.4, these postulations are coded as A1-A6. Based on these codes, Table 7.1 presents some deducted phenomena to look for in the qualitative study if exploration and exploitation are found in practice as what March (ibid) has described. According to the table, one of the main purposes of the qualitative study is to examine whether these phenomena demonstrate how exploration and exploitation are treated in practice, and whether these constructs are helpful in innovation management.

Table 7.1 Phenomena Derived from Six Postulations

Phenomena	Postulations
• (In a certain time period) there will be activities or processes in an organisation that can be classified as only exploration or only exploitation ➢ Activities based on keywords that involve in exploration can be successful without key words from exploitation, and vice versa	❖ A1 ❖ A6
• Organisations are aware and will try to control exploitation and exploration	❖ A2 ❖ A6
• When making decisions, organisations will have sufficient information about the outcome of the decision ➢ When decide to do exploration, they will only expect new knowledge without expectation on improving existing knowledge, and vice versa	❖ A2 ❖ A5
• When an organisation decides to search for knowledge completely new to them, they do not need existing knowledge at all, and vice versa	❖ A1 ❖ A5
• There will be a clear plan within an organisation to allocate resource for either exploration or exploitation	❖ A3 ❖ A4

Phenomena	Postulations
• Resources that are allocated on exploration will never result in outcomes related to exploitation, and vice versa	❖ A2 ❖ A3
• No serendipity exists in innovation processes ➢ All new products and/services/processes/business models are developed by an identifiable group of people that are aiming to 'develop new products/services/processes/business models' ➢ All improvement made on terms of existing product/service/process/business model are developed by an identifiable group of people that are aiming to 'improve exist product/service/process/business model'	❖ A2 ❖ A4 ❖ A5

7.3 Designing Focus Groups

Having operationalised the two terms of exploration and exploitation for the purpose of the qualitative study, this section will move on to presenting the detailed design of the focus group method. The following subsections present some aspects to be covered in focus groups designs, including the type of focus group, size and number of focus groups, and moderating of focus groups.

7.3.1 Types of Designs for Focus Groups

Based on categorising participants, Krueger and Casey (2015, pp. 30-34) point out four types of different focus group designs. Table 7.2 provides a summary of these types of focus groups. It is also noted that using different types of design is proposed for gathering more diversified views and obtaining more controls over the group discussions (ibid.). The purpose of using focus groups in this study is to generate open discussions on managing innovation organisations and to investigate whether innovation practices can be classified using the dichotomy of exploration and exploitation. Therefore, there is not much need to define specific categories of participants, and therefore, a single category design is considered more suitable. Krueger and Casey (2015, p. 30) also pointed out that the key to single category design in focus groups is for the researcher to collect data until no more additional insight is generated from the discussion.

Table 7.2 Types of Focus Group Designs

Design	Description
Single-category	Conducting focus group discussions with no specified groups of participants
Multiple-category	Conducting focus group discussions with pre-categorised audience groups
Double-layer	Adopted when categorisation of participants in the group discussions can be further specified
Broad-involvement	Allowing the focus groups to include participants from all relevant parties related to the topic

Source: Krueger and Casey (2015, pp. 30-34)

More specifically to the designs of focus groups, the number of groups and their sizes were considered. The number of groups is often depending on how many variables to control in the single category design (Liamputtong, 2011, p. 46). Since the intention is not to categorise participants in advance, deciding the number here is based on the consideration of richness of data and encouraging group interactions. Hence, at least three subgroups, which also allows triangulation of results from the discussion among them was decided in the design. In terms of size for each subgroup, it can commonly vary from three to fourteen participants with the ideal size per group is reported to be six to eight (Bloor et al., 2001, p. 26). To ensure interaction and sufficient time for every participant in the discussion to express their views, this study set a maximum of eight participants per subgroup as its design for the focus group discussion. It should be noted here that the design of focus groups conducted in this study will also depend on the attendance of participates, Subsection 7.3.4 will elaborate more on this matter. In addition, the group discussion can be divided into multiple rounds with different themes (Bloor et al., 2001, p. 29). Based on **Research Framework 2**, this study designed the group discussion to go through three rounds with each round having one theme; these themes will be discussed in the next subsection.

7.3.2 Developing Themes in Focus Groups

In the guide about developing questions for focus groups, Krueger (1998, pp. 9-12) compared two questioning strategies. One is the ‘topic guide’, which only lists topics of interest for moderators; the other is the ‘questioning route’, which provide a sequence of questions that should guide the direction of the discussion. Related to its purpose, this study has designed the guide for the moderator in a ‘topic guide’ fashion. Three themes of (1) innovation activities, (2) strategic consideration in innovation, and (3) communication in innovation are developed based on **Research Framework 2**.

Specifically, each of the three rounds will use one of these themes in sequence. The first theme for the discussion is innovation activities, focusing on what they are and what should they be like. The purpose of having this theme is to understand how participants see innovation activities, to get insights on whether innovation activities can be described as exploration and exploitation. This provides direct evidence for examining the definition of exploration and exploitation as activities. The second theme focuses on strategic orientations in innovation, with attention paid to how strategic orientations may influence the implementation of innovation processes and how innovation enables the accomplishment of strategic orientation. The purpose of this theme is also to know whether exploration and exploitation are viewed as strategic orientation in practices. The third theme concerns about communication in innovation, including a discussion on how decisions in the processes of innovation are made and how 'feedback' works in their process. The purpose of this theme is to understand whether exploration and exploitation influence future decision-making. More details of the three themes are presented in Appendix IV. While these themes provide a direction for the focus group discussion, the next subsection will present how these discussions have been moderated.

7.3.3 Moderating and Ensuring Group Interactions

Since group interaction is considered to be one of the benefits a focus group study can bring, in addition to the designs discussed in Subsection 7.3.1, attempts were also made to enable good group interactions through: (1) providing access to participants' own language, (2) encouraging the generation of more fully articulated accounts, and (3) offering an opportunity to observe the process of collective sense-making (following guideline by Wilkinson, 1998, pp. 188-195). These aspects can be ensured by carefully selecting moderators for each group. In general, moderators of focus groups should not seek to control the discussion in the group (Bloor et al., 2001, pp. 48-49). Hence, this study decided to recruit other people that are less familiar the topic of exploration and exploitation to moderate the groups. This should help to avoid the unintentional guiding of the discussion towards 'forcing data'. The selection of moderators was based on their knowledge on the overall topic of 'innovation' and the familiarity of moderators with the format of focus group studies; Subsections 7.3.5 will provide more details on selecting moderators.

7.3.4 Sampling for Focus Groups

It is a common practice in focus groups that participants should preferably be sharing common experiences. However, it is pointed out that there should still be certain level of variation in participants to ensure sharing insights during the group discussions (Bloor et al., 2001, p. 20; Liamputtong, 2011, p. 35). The sampling of the focus groups in this study is based on a community that includes memberships of companies and universities. Companies in this community are involved in manufacturing and product development and services. The focus group discussion took place as an event organised by this community. This event was advertised to attract participants that may be interested or have the knowledge in innovation. Details of this event will be provided in Subsection 7.3.5. The attendance allowed three subgroups to be formed for discussion, with each group having six participants (this is aligned with the designs mentioned in Subsection 7.3.1). Table 7.3 presents the list of participants of the focus group.

Table 7.3 Profile of Participants in the Focus Group

Pseudonym	Job Role	Profile of the organisation
	Group 1	
G1A	Project manager	Company A (test and measurement solutions)
G1B	Contracts director	Company B (manufacturing company for cooling and ventilation equipment)
G1C	Lecturer in strategy and innovation	University A
G1D	Project Leader	Company C (manufacturing company for engines)
G1E	Business improvement programme manager	Company D (engineering and designing electrical systems)
G1F	Researcher	University A
	Group 2	
G2A	General manager	Company E (manufacturing company of aircraft components)
G2B	Managing director	Company F (management consultancy)
G2C	Head of innovation	Company G (higher education institution)
G2D	Operations director	Company H (manufacturing company of electronic components)
G2E	Group managing director	Company B (manufacturing company for cooling and ventilation equipment)
G2F	Manufacturing engineer	Company D (engineering and designing electrical systems)
	Group 3	
G3A	HR manager	Company A (test and measurement solutions)
G3B	Engineering and quality manager	Company H (manufacturing company of electronic components)

Pseudonym	Job Role	Profile of the organisation
G3C	Partner	Company I (consultancy)
G3D	Director	Company J (business support service)
G3E	Test Manager	Company D (engineering and designing electrical systems)
G3F	Supply chain analyst	Company K (manufacture company in air or spacecraft related components)

7.3.5 Conducting the Focus Group

This subsection presents in more detail how the focus group were conducted. This also covers data collection during the focus group. With three themes developed in Subsection 7.3.2, three other doctoral students who all have research topics relevant to innovation were selected as moderators, because they all have experience of running focus group discussions in their own research. A briefing section two days before the focus groups was provided to the moderators supplemented with a detailed note explaining the themes of the discussion with example questions included (see Appendix IV for details of this note for moderators).

This then led to the event where the focus group took place (Subsection 7.3.4). This event started with a 20-minute presentation by the researcher before the discussion. This was to provide an overview to this focus-group study along with some key terms, such as ambidexterity. In addition, this presentation also included information on how this focus group discussion will be conducted (according to the design in Subsection 7.3.1). Three groups of six participants then had the discussion based on the themes. Before the discussion on the first theme, participants were given a piece of paper that had the keywords March (1991) used to define exploration and exploitation in a random order (with the word innovation removed, see Appendix IV). Participants were asked to encircle the words they thought would fit their understanding of innovation activities in their organisations. A blank space was provided in case they wanted to add additional words. The purpose of having this activity was to provide a starting point or warm up to the discussion (see Kitzinger, 1994, pp. 106-107). Furthermore, this paper acted as one source of collected data to see what exploration and exploitation may mean in practice. The discussion was based on the three themes (Subsection 7.3.2), with each theme taking about 25 minutes. Post-it notes were provided for the participants so that they could write down additional thoughts after the discussion. A debriefing section took place with all the moderators after the focus group discussion, notes and initial thoughts on the discussion, including the verbal and non-verbal communication, were shared (commensurate with Kidd and Parshall [2000, pp. 288-299]).

This focus group discussion was thought and approved by the ethical community in the social science college, University of Glasgow; this is shown in Appendix VII. Participant information sheets ware provided to all participants and signed consent forms collected before the discussion. This provided permission for all discussions in the subgroups to being audio recorded. The papers that were handed out before the discussion on the first theme were also collected after the discussion. In addition, notes were taken by the moderators during the discussions. These recordings and notes then act as the main data source for the qualitative part of this study.

7.4 Data Analysis

With the description of how and what data has been collected in the focus group, this section will discuss how data was analysed. Generally, data analysis in the qualitative part of this study followed generic guidance of qualitative analysis. The first subsection will explain this generic guidance and how they have been applied to the analysis. The following two subsections will go into more detail about the two cycles of abstraction and interpretation processes that have led to findings. Considering the features of data from focus group, the last subsection will discuss some techniques that have been implemented to support the data analysis.

7.4.1 Procedure for Data Analysis

This subsection will provide an overview of how qualitative data was analysed in this study. Generally, the analysis of data in this study has relied on both exploratory and explanatory analysis methods and followed an interactive and circular procedure. This included the activities of: (1) data condensation, (2) data display and (3) conclusion drawing after data collection (Miles et al., 2014, p. 9). The first cycle of abstraction focused more on explorative analysis. The purpose of this first cycle was generating codes to generalise the raw data collected based on **Research Framework 2** (Subsection 4.4.6). As noted in Section 7.2, exploration and exploitation will not be pre-defined in this part of the study; therefore, the initial coding will not be based on exploration and exploitation. The first cycle is discussed in more detail in Subsection 7.4.2. In the second cycle, the abstraction was focused on explanation building of the codes. The aim in this cycle was to link the initial coding to the main concepts of exploration and exploitation, and to generate findings that are related to the overall research objectives. Details on the second cycle are discussed in Subsection 7.4.3.

7.4.2 First Cycle: Initial Coding

More specifically, the first cycle of abstraction is mostly about the process of 'open coding', where 'ideas' are generated directly from raw data, and ideally, all possible 'ideas' should be captured (Corbin and Strauss, 2007). Although open coding should flow freely, it is impossible to abstract every possible idea. Therefore, open codes are developed by both induction and deduction (ibid.). The main purpose of open coding is to get an initial abstraction of the raw data and link them to theoretical constructs. For instance, in this study, the examples participants provided about how to choose what idea to pursue for innovation outcomes can be coded as 'selection: what idea to go forwards'. These codes are presented in more details in the tables demonstrating the results from the focus groups, together with the quotes that are related to each code.

7.4.3 Second Cycle: Explanation Building

After the initial coding, the next step was to categorise similar codes together. This was for the purpose of having another abstraction of the codes. For example, the code 'customer' can lead to different perspectives in the discussion, including impact of customers on successful innovation, implementing strategies and factors affecting decisions in innovation processes. A more direct example of this categorisation is the keywords that March (1991) proposed to define exploration and exploitation. These terms are clustered together, under the theme of 'reflection of keywords in practice'. Hence, the main purpose of this step is to contribute to a clearer explanation of the data.

The last step in the analysis focused on explanation building, which means to link the analysis to the notion of 'exploration and exploitation'. One of the key purposes of the qualitative part of the study were to explore how exploration and exploitation are reflected in practice. However, since they were not pre-defined (see Subsection 7.2.1), the initial codes were not necessarily related to this dichotomy. The step of explanation building then aims to see how the codes can reflect exploration and exploitation in practice. This last step will then lead to findings that are related to the research question 3 (Subsection 5.9.1).

7.5 Results from Focus Groups

This section presents the findings form analysing the focus group data based on the three themes discussed in three subgroups of the focus groups. The first subsection provides an overview to the discussion in the three subgroups. For findings of each theme, Subsections

7.5.2 - 7.5.4 will therefore describe the main topics discussed by each of the three subgroups under each theme. This will include both verbal and non-verbal communication, and move on to present the initial coding based on the data collected. This section will end with Subsection 7.5.5 presenting the key findings of this focus group study.

7.5.1 Overview of the Group Discussion

Overall, the three subgroups have shown different characteristics in terms of how the discussion flowed (the three subgroups are named Group 1, Group 2 and Group 3; see Table 7.3). In Group 1, because there were two participants from the 'academic side', they sometimes interacted with other participants focusing slightly on different aspects of innovation. According to the note provided (Subsection 7.3.5), the moderator in this group made sure that the discussion was based on the theme in each round, but with less control on which specific topics to focus. The discussions in this subgroup turned out to be between structured and flowing freely (this is concluded based on listening to the recording of the discussion). In Group 2, the moderator followed the questions provided in the 'notes for moderator' (see Appendix IV), the discussion at some point is like participants answering questions in turn. However, there were still signs of interactions between the participants. The discussion in this group were more structured based on listening to the recording of the discussion. Regarding Group 3, because one participant is a human resource manager, the discussion in this group tended to have slightly more focus on the 'people aspect'. The moderator in this group just introduced the overall theme and had minimum intervention to the discussion. As a result, the discussion in this group was more unstructured. The following subsections will present details on the discussion in each subgroup under each theme.

7.5.2 Theme One: Innovation Activities

The first theme discussed in the focus group was innovation activities, which refer to the two sets of keywords that March (1991) used to describe exploration and exploitation. Hence, most of the discussions were centred on what do these keywords mean in innovation and examples of how some of the keywords reflected in the daily practices of the participants. Note here that what was referred to as 'innovation' by participants varies in the discussion. In presenting their views, this study will be consistent with the distinction made in Table 2.2.

The discussion in Group 1 started with how keywords about exploration and exploitation are reflected in managing innovation activities of organisations. This was mainly driven by the importance of 'play' and 'experiment' linked to idea generation. The discussion then shifted

to the different importance of 'play' and 'experiment' in radical and incremental innovation before it was interrupted by one participant asking about how this links to their strategy. The discussion was brought back to innovation activities when the next participant started to talk about how to 'search' for ideas. Searching for ideas brought up the discussion on the importance of external linkages, such as industrial networking and regional innovation systems. However, participants agreed on that ideas can come from every aspect of the work with an organisation. This has led to discussing the testing and selection of ideas. Participants shared few examples of how the selection of ideas works in their organisations. Group 1 ended this round with a brief touch on how selected ideas can progress in innovation processes. Overall, the participants shared their understanding on what 'innovation' means, as shown in the **Quote 1**.

> *Quote 1: "R&D is all about allowing money to make knowledge, innovation is more about allowing knowledge to make money." [G1C]*

In terms of non-verbal communications, discussions around 'industrial connections' and 'selection of ideas' received more interaction and agreed, whereas radical and incremental innovation received less attention from the participants, as shown in **Quote 2**.

> *Quote 2: "Because it's only academics we only talk in terms of incremental and radical innovation because that's not how industry works. You know I mean industrialists don't care. You know whether the idea is incremental or radical as long as it works." [G1C]*

In Group 2, the discussion started with all participants sharing their understanding of the keywords and how these words were related to innovation activities. Hence, there was limited interaction during this part of the discussion. The main aspects participants shared included the mind-set to make changes, discovery as a bottom-line for innovation processes, importance of risk-taking (even in refinements), searching for and execution on innovation activities, and selection of ideas based on the benefits of innovation outcomes. During the discussion, one of the participants shared some understanding on what innovation activities mean; this is shown in **Quote 3**.

> *Quote 3: "Innovation (activities) is like…we are getting a whole redecoration at home... But redecoration activities include finding a decorator by looking at yellow pages, getting them to come and all that things. All of these relates to innovation activities, but I wouldn't define them all as innovation (processes) because innovation (processes) is about taking the new ideas that's discovery or refinement and forward. Would be radical and refinement would be incremental and then putting them into practice, which will be implementation or execution.*

> *But what I noted was there's nothing here about delivering a benefit and it's like I said earlier innovation (processes) is absolutely about delivering the benefit. If you have a great idea and put into practice and nobody buys IT is not an innovation (outcome), IT's just another failed product" [G2E]*

The discussion then moved on to how organisations may manage different types of innovation processes (mainly in terms of the source where idea for innovation outcomes comes from). This then brought up a lot of interactions and discussion that mainly focused on three topics of: (1) customer feedback, (2) benefits innovation outcomes may bring, and (3) lead time in innovation processes. With regard to non-verbal communication, because discussion in this group was taking place in a more structured manner (see Subsection 7.5.1), there was limited interaction when participants were talking about the keywords provided to them. However, the discussion on benefits from undertaking innovation activities and the importance of customer feedback interested the participants, and thus, brought up more interactions.

Group 3 was less structured; the discussion did not start with participants sharing their thoughts on the keywords and how the words related to innovation activities. The first topic put forward by this group concentrated on why organisations need to innovate. Based on this, participants touched upon keywords such as variation, experimentation and discovery. They then linked the discussion to the benefits or paybacks of innovation outcomes. One participant pointed out that the innovation process itself means uncertainty. Whether it is incremental or radical, the key is to ensure the overall success as an outcome. Another participant than added capability into the discussion, but it did not create much discussions; rather, the focus shifted to managing risks and how external factors (such as industry 4.0) may have impact on innovation processes and outcomes. Then learning was pointed out as an important factor; here, the participants mainly meant 'learning from failure' as a way to motivate employees after a project fails. This led to the discussion on the importance of managing culture and people in innovation (mainly brought up by participant G3A, a HR manager). In terms of non-verbal communication, topics around how to manage people in innovation (for example, mind-set, dealing with failure and culture) received most interaction in Group 3 (with signs such as nodding noted). Topics about capabilities and what actually innovation activities mean was not discussed actively.

To sum up, the discussion under this theme covered how the keywords proposed by March (1991) are linked to innovation and participants provided their understanding of what these words mean in the context of innovation processes. Some additional keywords were also put

forward. The discussion covered limitedly the meaning of innovation activities and the essence of successful innovation processes that led to outcomes. Topics about benefits of innovation outcomes, external connections and customer feedbacks were covered in greater detail. Based on the discussion, Table 7.4a, 7.4b and 7.4c presents the initial coding under this theme. The initial codes are organised into three broad topics: Table 7.4a on keywords proposed by March (1991), Table 7.4b about additional keywords related to innovation, and Table 7.4c regarding the essence of generating successful innovation outcomes.

Table 7.4a Initial Coding: Keywords from March (1991)

Codes	Quotation
Play: for idea generation	· *You know, for example play, at least in terms of idea generation is important.* (G1A) · *I think play, well, occasionally. We should do more. But we don't do that much. The issues of ideas are, in the first place, how you're getting them.* (G1D) · *You need the mind set to say okay, play is important, you try to make it fun before good ideas appears.* (G2A)
Searching: starting point of innovation	· *Search is the first one I circled. I guess we are like large companies with a formal innovation procedure that start always with searching for the innovation… Searching for ideas, ok, what I mean it's like there's kind of trained searching. So, like, may be encouraged to read different journals and magazines and trying to note the things you've seen that may be interesting.* (G1D) · *Daily jobs sometimes do but not necessarily always lead to radical ideas. This is why they really need to speak to people in universities and that's where I think personally that we're messing.* (G1D) · *We have a huge number of people doing different things from education to consultancy research. So, for me search where the innovation is within the organization is the first come into mind.* (G2C)
Selection: What idea to go forward	· *Team leader will always go for selection but as well as for experimentation. And it may fail and doesn't getting to proceed forward.* (G1D) · *We kind of trust this selection for all the ideas based on expertise and current knowledge. So, what we do is we create situations like… um… dragon's dens. We make sure that whatever ides proposed go through this process and then we decide what to select.* (G1E) · *Innovation can be a lot about actually choice. You can't work on everything, so you have to have some ways of deciding what you know, what you're going to focus on, so selections are very much like choices and is key.* (G2D) · *All those other things we can try, maybe they are good. Sometimes you want to put something in place because it is something new… but you want to make sure that there are benefits and then based on that... We need to be selective and chose something that could bring benefit.* (G2F) · *(for selection) there is a fair mix of people, you get people from procurement you get engineering and from production, manufacturing sort of stuff in discipline in the company, you sort of combine this expertise and then select ideas.* (G3B)
Linking to radical and incremental	· *I think if you're trying to do something radical than the play, experimentation piece is very important than you trying to do some incremental. IT's not that it is not important but probably less so. IT's more about how you can kind of refine what you already know. In incremental situations, learn a bit more about something arise from somewhere else.* (G1A)
Refinement: important when having a target	· *It tends to be more about trying to refine an idea and develop it. So, it's kind of more like we know what we're actually set out to do, because it tends to be increment and focusing on something done before. It might be faster or more accurate.* (G1A) · *So, to me, when talking about refinements, you know, there is always a strongly focus.* (G2B)
Discovery: bottom line	· *The bottom line (of innovation) is about discovering. You ensure that and then have to giving people the freedom for them to use a creativity.* (G2A)

Codes	Quotation
Risk-taking: nature of innovation	· *I went with the risk taken because innovation in any shape or form is about managing risk.* (G2B) · *I tried to persuade people saying, yeah, it's risky but if we don't, we are losing our chance of having things that are successful.* (G3C)
Execution: getting things done	· *Execution, you know, once I select your proposal or idea, you really need to do it and deliver.* (G2C)
Production: make something	· *I think production is important because you know you want to be innovative, you have to make something out of it and sell it ultimately.* (G2D)
Combination of variation, experiment, refinement and discovery	· *For innovation, we were talking about you need to be innovative in the production process to help us be more competitive especially in price. We can spend more money, we can grow our capacity to make ourselves cheaper, we can find quicker, easier, more flexible ways making the same product. It can be a change of (production) process, or just the same process but better. I'd say then what we do, is like variation, experimentation, refinement discovery.* (G3B)

Table 7.4b Initial Coding: Additional Keywords

Codes	Quotation
Capability	· *I did not find a word here is capability… we're looking for ways to innovate, get more efficient, be more capable of doing things over the next five years. It's about our capability to do that in the first place.* (G3C) · *Without capability to actually support innovation noting can happen. Like in our company, somebody came up with an innovation years ago and it was amazing. It was an electronic engine and the company went… nah not allowed to, it may be much cost to the car, and nobody would want that… but now everybody have electronic engines…* (G3B)
Budget	· *It was a decision; we're going to do this but not funded by this not funded by that budget. Then it's about finding or having the budget to support that…* (G1E)
Dealing with problem	· *When you do the innovation in the first place and I may not state that in the beginning but at least you be able to identify problems or dealing with it as a task.* (G2B)
Learning (from failure)	· *Another word that would maybe not there um you could you could add is learning. Innovation and learning absolutely inextricably linked as far as I'm concerned.* (G3E) · *Definitely at the end of a project, you see was it successful or not. But preferably a few points during the project, of what we call the 'lessons learned' and it was always looking for what could we as a team do differently. Not what should the management have done or what could management do it in another way. It's all about what we can do differently.* (G3B) · *The thing sometimes is about what we can learned from it. if you sort of manage that within an organization to make sure you do it differently next time, then it (the failure) is not wasted.* (G3A)
Benefits (or value)	· *For an idea that get to the end, say three months to six months. Then they come along as a team or one member of the team, comes along and presents the output and the benefits.* (G1E) · *Everyone has the chance to submit an idea that they think would have technical benefit.* (G1D) · *Value and creativity for me. To me that's the definition of innovation, so this value, this benefit, it defines innovation.* (G3C)
Time	· *Turnaround time is like a metric. This is also linked to deliver the outcome considering the matter of cost.* (G2A)
Uncertainty	· *Another conversation that you also link with any innovation is that because it's all about the future and stuff you don't know. So, you're always talking about uncertainty.* (G3D) · *That's part of the search in technology level. I mean it's this interactive approach in R&D. You try, failed, you try again, fail again. This is a proper management mentality, always, that say you're doing something, but you don't necessarily know*

Codes	Quotation
	the outcome. You're on a journey you have to accept that uncertainty is always the case. (G3B)
Change	· *I think absolutely right to me, innovation is about change and always refer to change.* (G3C) · *Creative or if you say, innovative people are probably the ones that are more open to change. They're the ones that are going to go and look for changes rather than hope a project could work.* (G3B)

Table 7.4c Initial Coding: For Innovation success

Codes	Quotation
Process for innovation (progress ideas)	· *The idea here is to keep up with the concept, and here's how we're going to progress that through. Towards how we make this available in the marketplace. (G1A)* · *In innovation now, what we want to try is about creating a process, standardized processes (for innovation).* (G2A)
Commercialisation	· *Commercialising an idea is hardest things and we seem over and over again.* (G1B)
External networks	· *It may be really beneficial from you knowing these organizations or being in your partners.* (G1C)
Customer: importance of making sense	· *If you're going be customer focused, the key is to listen to not what they say, but what the customer means.* (G3E) · *It's not all about what customers say they want, it's about what does a customer trying to do.* (G3D)
Customer: potential harm	· *For innovation it can't always about customers. It needs to have that disconnect, or some innovation will have that disconnect, because nobody's asking for it.* (G2E) · *But if you are innovative, you maybe don't want to listen to customers… Edison said he would have invented a better candle he wouldn't have invented the light bulb ford says he would invent a better horse rather than a car.* (G3B)
R&D and innovation	· *R&D director once told me a story when we were talking about streams, approaches to innovation and all of that. You know. A clear distinction between R&D and innovation is made yeah, R&D is all about allowing money to make knowledge, and innovation is more about allowing knowledge to make money.* (G1C)
People doing innovation (engaging employee)	· *Not just so-called innovators that are dedicated to doing something new, is also the people doing the jobs day in day out. When are they going to do innovation but need to consider whether they have the time?* (G2C) · *Doing innovation is more like on a day to day basis. For one, is understanding available processes and how to improve them. For some is to reduce cost or coming up with new products or designs.* (G2D) · *The idea of involving employees. That's a good one but not enough companies do that. You said you want to be innovative and you want a more innovative culture, you need to think whether the employees have the skills to work in an innovative culture as well.* (G3A)
Overall success	· *You don't know if any one particular investment success… and the projects that you started within that, you should have a portfolio. Some radical some incremental and in different areas. Then you should be able to ensure your innovation efforts will be success overall. But maybe the two thirds of those projects fail and you're relying on ten percent to actually give you profitability.* (G3D)
Define innovation success	· *It's really difficult for you to define what you can call innovation success. Because I guess success is the engine didn't break down etc. but that's only until it does then you know…* (G2E)
investment	· *You probably start from a position of thinking big investment. You know we're gonna do something very, very different in the process. Maybe we'll get a pretty big investment so that you know, you need to make a case they will pay off.* (G3D) · *As long as you look at what's the payback out of work for a company that looked at an investment said no, that's too much. We have to do cheaper rather than saying, just because it's new then we're doing it.* (G3C)
Culture	· *What innovations for me is having an innovative culture within the business… we need to start getting this organisation to innovate and create that culture of innovation.* (G3A) · *It is the culture of innovation that you know being innovative is supported through all levels.* (G3B)

Codes	Quotation
Financial performance	· *We tell everyone is to move this organization forward, through you guys doing innovation. But it's not a charity it's a business we are here to make money.* (G3A)
Source of ideas	· *In our company, so we gather ideas from the one… Say by a number of mechanisms known that collect ideas throughout organisations.* (G1E) · *Ideas didn't come from nothing, often it was on the back of somebody else doing a research study and you had a work from somebody else.* (G1D)

7.5.3 Theme Two: Strategic Considerations in Innovation

The second theme in the focus group discussion centred on how a strategic orientation can influence innovation processes and how innovation outcomes enable the accomplishment of strategic orientation. Therefore, the discussion under this theme is based around strategies set by the participants' organisations and how they have worked to accomplish these strategic goals in the context of managing innovation.

The discussion in Group 1 started with participants sharing the strategic orientation within their organisations. These orientations are mainly about being competitive or becoming the leader in the industry. However, one participant was unwilling to share too much on the company's strategic orientation. During the sharing of strategies, one participant briefly asked about the choice between acquiring technology and developing technology organically, but this point did not catch much attention. After sharing the strategies, the discussion moved on to how these strategies are 'shown' in practice and what each organisation has done to achieve its strategy. Two main points were mentioned as 'building innovation processes' and 'translate strategies into specific daily practices'. The discussion then shifted to 'changes'. This include changes in organisations affected by external changes (e.g. industry 4.0 and technology evolution). The last main topic discussed under this theme concerned how changes in strategy may affect innovation, how to manage this change and the importance of involving employees in dealing with changes.

With regard to non-verbal communication, one participant was defensive and unwilling to share the company's strategy. The brief discussion about organically growing technology did not seem to interest the participants, with them not being active in terms of body language. Topics, such as importance of involving people in realising strategy and dealing with change, showed signs of more interaction between participants.

Alike Group 1, the discussion in Group 2 also started with all the participants sharing the strategic objectives of their organisations. These strategic objectives covered 'protecting intellectual properties (IPs)', 'being leader in the sector' and 'competitiveness'. One

interesting example is from a participant stating that they have two sets of business with different strategies. For each strategy, the organisation implemented different activities trying to achieve it. The focus of discussion then shifted towards how to realise the strategies. The first topic proposed here was about translating overall strategies into specific priorities. This was linked to interactions with customers to determine directions for organisations. One participant asked about the risk on focusing too much on the customer, which triggered a discussion on 'time-to-market' and how to effectively use feedback from customers. There were also discussions on sharing experiences between divisions in organisations before the main focus shifted to how to manage strategic changes. Things discussed here included: the difference between short, medium, and long-term strategical goals with also attention paid to 'constantly evolving' strategies. The discussion then warped up to the importance of engaging employees and the thinking 'no need to do more'.

In terms of non-verbal communication, topics such as the impact from customers and 'no need to do more' seemed to be attracting the interests of the participant more. Interaction was limited when listening to other participants explaining their strategies and what they had done to achieve the strategies. For example, there was signs of not paying attention and looking at the table instead of making eye contact when a participant was talking.

Unlike the other two subgroups, the discussion in Group 3 focused more on the general impact of strategy on innovation instead of strategies specifically to an organisation. The first point mentioned is having an innovation strategy that is different than the business strategy. This was linked with to what extent the consideration of financial performance and cost should affect innovation strategy. A common understanding reached among the participants was that having innovation outcomes lead to growth, and thus, managing innovation processes should be an important factor to consider when forming strategies. One participant pointed out that the interaction between strategy and innovation is more suitable to be described as a two-way interaction.

The discussion then focused on 'strategic innovation mission' and also how innovation (or rather ideas) can point to new strategies. This understanding brought the discussion to the influence of 'failure' on innovation processes and risk-taking. One participant brought up the outcome of a 'smart kill' and linked this to decision-making in innovation processes and activities. Similar to the discussion in the first round, the focus shifted to the importance of engaging and training individuals, and having an innovative culture. However, the meaning of this 'innovative culture' was not further specified by participants.

In terms of non-verbal communication, it seems that because of this unstructured style of discussion, participants showed interaction and interest to all the topics discussed in this round. Interactions among participants appeared to be richer when discussing training, failure to innovate and smart kill.

To sum up, the discussions under this theme provided insight on how strategies and innovation activities, processes, and outcomes are related in the words of participants. Much attention was paid to how strategy can be translated into daily practices for innovation, which was part of the next theme. The importance of engaging employees throughout innovation processes was frequently mentioned. Participants have also emphasised the influence of the customer and external changes on managing innovation. Table 7.5a, 7.5b and 7.5c present the initial codes based on the discussion under this theme. Based on the discussion under this theme, the codes are organised into three main topics: 7.5a on strategic objectives of organisations, 7.5b about realising strategies, and 7.5c regarding impact of change in strategies on organisations.

Table 7.5a Initial Coding: Strategic Objectives

Codes	Quotation
Dominate in the market	· *Today it's been about dominate in particular markets segment. (G1A)*
To be the leading organisation	· *Our strategy is always to be one of the world's leading organisation providing the service in the industry. (G1D)* · *We want to become sort of leaders in the sector. So, we want to be the lead research and also consultancy in our area. (G2C)*
Searching for alternatives	· *Part of our strategy is now more on finding something else to make and what else can we make. (G1D)*
Searching for improvements	· *In terms of strategy they say focused on uh maybe three key production lines and trying to make improvements. (G1A)*
Protecting IP	· *We have made a lot of innovative products, so a major focus now is all about protecting our IP. (G2A)*
Faster cycle time for new products	· *Our value proposition is all about in fast cycle time and for prototype and then new products. (G2D)*
Maintain margin	· *For the part of business of the construction new builds. We don't necessarily want to chase more business because we already have a big enough share of the market. We want to get better at doing what we're doing. Um. IT's quite a risky business, so there's always the danger the margin gets eroded because things go wrong on sites or unexpected happens. Getting better at managing those challenges and maintain that margin or even improving the margin. (G2E)*
Recruiting for innovation	· *On the operation side of the business, we're working absolutely flat out. If we have more staff, we would use them. The strategic goal there is to recruit more people and innovation in that respect is more about like you're talking about the cycles and get through. (G2E)*
Stay competitiveness (keep people)	· *For us is more about probably competitiveness… strategic focus is to keep people in the business. (G2F)*
Innovation strategy	· *I've seen a couple of companies, work with a couple of companies that got around and uh they tended to have an innovation strategy independent of the business strategy. (G3B)* · *We might try and call those the strategic innovation priorities or if you like the strategic innovation mission. If you look out, is a strategic*

Codes	Quotation
	innovation mission when you looked at what the company's trying to do within that. It's like what do we not know, how to do, what are the problems, and what gaps are there in terms of achieving that strategy. (G3F)

Table 7.5b Initial Coding: Realising Strategy

Codes	Quotation
Lack of capability	· *What's difficult is you know if you're making trials and sometimes already made (prototypes), you can get the manufacturers asking them to help here. They don't really want to help, or they are not able to help on new products, because they don't have necessarily the right assemble line or the right procedures for the new stuff. (G1D)* · *We realised sort of where we want to go but we recognize that we don't have the skills to get there(G1A)*
Customer	· *You want to supply your customers' needs. You have to, to make sure you are still making business. (G1D)* · *Well, there is a risk that you get gradually edged away from what you're targeting if you are focusing on the customers too much. (G2E)* · *For us we focus on making the deliveries rather than how we make the delivery. So that it's still about meeting the customer needs but it's also about doing it better. (G2F)*
Building 'system' for innovation	· *We're actually going out and then bring somebody that can help us develop a process effectively, making us a more innovative company. You know, the process for innovation. (G1B)* · *To do what we want to do in terms of cycle time, we were planned to do is to develop our own process model. Process model that can guide the whole you know, innovation towards the end. (G2D)* · *Sure, people that can be innovative they have a system in place to help them. (G3B)*
External advice	· *We are looking for ideas from elsewhere, you know, not only within the company. (G1B)* · *We try to get, and you know, understand some more ideas by speaking to more people and having more links with more universities. (G1D)*
Core value to employee	· *We have this, four core values or call it the four cornerstones of the businesses that reflects on the company vision. It was just handed to all employees so as everybody was aware. (G1E)*
Feedback on what has been achieved	· *Where we take that strategic objective and create a short sample of what has been achieved. The level that part of its strategy so then it is about telling people what successes have been achieved to date. Not a long session, actually would like two slides power point presentation, so that the various members of the team is clear on strategic objectives for each month and they involved in the processes and being informed of how the strategy is being progressed. (G1E)*
Innovation manager	· *We have an innovation manager who is also in charge of the test lab. (G1D)*
Importance of time	· *Time is important actually because again small companies can't afford to lose hours. They are quite load and would tend to be pretty busy doing what we're doing. (G1E)* · *Will I think we have to be very careful and I think it will be a much focused on products developed and delivered to market. But make sure that our offering is going be the first to market. (G2D)*
A place to innovate	· *To me innovation is creating a kind of place that can innovate. So yeah, it's culture, it's a lot of things, you know, supporting environment. (G1E)*
Involving employee	· *How do you get employee engagement and the part of the business is not just the day to day job, it also has to be linked with the strategic developments? (G1E)* · *They're all very busy people and hard working in the company. Everybody is you know mostly quite stretched that we don't have a lot of people say do some innovative thing or additional workload. To be innovative and encourage that culture means getting people to feel free for additional things and getting this information across as part of your job. (G3A)*

Codes	Quotation
Alignment: setting priorities and finding misalignments	· *We're got an alignment. To make sure that for the company's overall strategic like everything's on. We then set certain priorities based on what alignment criteria has set us to do. We will see if our goal, our sales our new products find itself in misalignment. That's the analysis. This is where we need to focus. This is what we need to go. (G2A)* · *Aligning strategically with the overall organizations and well, we are reorganizing actually, uh, the whole uh, place. (G2C)*
Training employees	· *Our goal is, at the moment, about eighteen maybe to twenty-four months for training the employee that I have mentioned earlier. Primarily because we can't give the guys all of the experiences that they need quickly enough. Sometimes because we tend to say for example, recruit someone in our Bristol office. They tend to only work on jobs in the Bristol area and there may be a really interesting job happening in Aberdeen. But we would send a guy to Aberdeen just to get the experience and I think that's where we need to focus on, how we can get them through the process faster. (G2E)* · *For training employee for innovation, you don't exactly train them to be innovative, you trained them to solve problems. Because that's the core of innovation. It's like you will get problems and finding a creative way to solve a problem. (G3A)*
Road map	· *Setting the overall target, again, you get senior managers as part of the process and you develop that vision where the company will be in five years. Taking part of it will be the strategy to get there and then you see if you could relate all these improvements that aligning with the business strategy. And how all these ideas are coming and if they are not in line with that, you know the road map. (G3C)*
Dealing with failure	· *Because we're a high growth company and we are 12 years old now. Okay when we see you know, that product is a failure, it's in a learning program format, but at least the important thing is we know what we'd do differently next time. (G3B)* · *That's absolutely, there's no success without failure to keep something going, and can teach us how to do better next time until the success. (G3F)* · *It's not in the case of saying well it wasn't really a failure because we learnt from it. Admit a failure was actually the first step… if you if you try to hide the fact that it was a failure then you have less likely to get people to see this limitation and have less impact on what you could have done differently. (G3C)* · *One important thing about managing innovation is don't praised the success. Praise the failures. You took the risk, but it didn't work out, good for you to take on this. But even in later, praise the risk-taking action… But to me that's the important things like if you want people to take risk you want people to be more open. There's a risk of failure, then praise that, don't praised the success, make sure what to say to these guys they tried, and it didn't work out too much, but well done and congrats. (G3B)* · *In managing these projects, some had failed so I want to move onto the next project. Because they did not want to be associated with failure because in the company, they fear that will be a killer for your career they thought. I was involved in a lot of failures and it didn't kill my career. (G3C)* · *Most new ideas will fail. You know I think you have to accept that this is the case. Most will fail, and you set yourself up, accepting that and moving on. (G3B)* · *There are two potentially very good outcomes from the innovation effort. One is the innovation goes to commercial stage and you can sell products and so on because all the things you do to do the fantastic. The other is a smart kill. So smart kill is when you kill a project for the right reasons as fast as you can and as cheap as you can and then you can move on your next project. (G3B)* · *I used to say as project managers, innovation project, a research project, cannot fail. Because what you're trying to do is, you're trying to answer the question. Is it possible to commercialize this idea? Some point you're getting the confidence of either that is going to commercialize or you're going say no. But if the project gets to the point where he can see that it's not going be possible to commercialise. You understand why that's the case and he should say as soon as it's clear that it's not going be possible. (G3E)*
Innovation as a tool	· *To me the key thing here is that I don't do innovation. innovation is a tool it's not an end in itself either it's a tool to deliver the market strategy etc. (G3D)*

Codes	Quotation
Linking with people strategy	· *You know we innovate for growth, and that is always linking to our people strategy. (G3A)*
Buying vs developing in house	· *They say there's a make or buy decision as it's going to be too costly for us to develop certain things by ourselves. You know what we can buy when we need it. (G3E)* · *That's when patenting sometimes and having intellectual property can make a fortune. Yeah. Because you don't have to make it… just have to sell the license. (G3C)*

Table 7.5c Initial Coding: Impact of Changes in Strategies

Codes	Quotation
External changes (industry)	· *A key trend which will hit all industries is how… in the automation is going to hit full sectors and any firm of business today is definitely not going to be do the same thing ten years from now. (G1F)*
External changes (technology)	· *Well, it then the decision of, let's start use AI. In terms of making the product, it's very much then focused on industry 4.0. Thinking about automation because some of our products are a fairly high volume. (G1A)*
Internal changes	· *In terms of innovation, because one of the things we've been doing is trying to do more and more work in our workshop before we get to site. Because traditionally what we do would be all of its delivered onsite then construct a system out in a field somewhere in the region. With all the mountain, all the rest of it. Um, if we could do that in the factory and cut down the site time where our margin slippage happens primarily is on site because that's where that's the biggest unknown. (G2E)*
Finding collaboration	· *All our changes including this new approach to closer relationships with industry and to innovate within our walls. (G2C)*
Long term planning	· *we said with a five-year strategic version, five-year strategic plan, with expectations from financial performance and innovation in it as well…… people don't like change, so they usually avoid it. (G2A)*
Innovation for new business	· *I don't see you can't progress the occasional idea that doesn't fit the strategy. Because it might take into new businesses. (G3B)* · *The point is innovation may not fit your strategy because they may point for a new strategy(G3E)* · *If you see an opportune in an area that's not core for the business doesn't mean that you reject it. Just make sure you're not spending ninety percent of your innovation budget on things that are not core. Or might allow yourself ten percent innovation budget and things on things that are not core. (G3D)*
Inclusion of employees in innovation	· *We were asking before is everyone to produce some sort of report on continuous improvement. Everyone get comfortable and is not that difficult. I said that, okay, if I'm doing that, like that, and we can do it a wee bit better, than we have a wee bit of a project. Um doesn't need to be perfect, as long as it was better than the ones before, so that's how we can get people engaged. (G2A)* · *Just start to get people involved and things that are just a day job and seeing as a developer that if you want to be a part of something. It's not for everybody but those little things you can do. It doesn't have to be on official innovation course but making them part of the process. (G3F)* · *In our company obviously, everybody sees themselves on the day job… and innovation is over above. We are looking to change this. (G3B)* · *Employee involved in innovation and tell them to link this to the future the company. This should also be an important thing, just like their daily jobs. (G3A)*
Culture change entering a new market	· *Massive cultural change because for example I've got a sales data and not the UK based but we need to look at additional strategic marketing activities and entering new markets. (G3A)*
Don't need to do more	· *I think maybe the biggest change is the recognition that we don't necessary want to be doing more. You build contracts, we want to be doing what we're doing better. (G2E)*

7.5.4 Theme Three: Communication in Innovation

The third theme of the focus group discussion was related to communication in innovation processes, touching upon how decisions are made in innovation processes. This theme has also focused on how different individual and departments communicated throughout the innovation process and how information has been passed around an organisation.

In Group 1, the discussion was linked with the last theme but with more detailed provided on how exactly strategies formed at a higher level of management were passed to the rest of the organisation. These specific activities to communicate strategies include coaching sessions for employees, meetings about short-term objectives, along with regular meetings between different functions in the organisation. There was a question asked by one participant about the influence of firm age and two of the participants started to discuss how firms can survive longer, linking to how businesses are run by families. However, this did not draw much attention and the focus quickly shifted back to how small organisations are passing information around. One participant pointed out that because the organisation is small, it is easy to have everyone involved and share information.

The discussion moved on to challenges in communication. Participants agreed that communication between functions are sometimes difficult to manage. 'Timely communication' was identified as a key in managing innovation and one participant shared the experience of having an 'innovation hub' and its usefulness for collecting information and making more informed decisions. In the end, the importance of budget was mentioned, which was linked to how resources (including people) were allocated to different innovation projects.

In terms of non-verbal communications during the discussion, time, budget and communicating strategy within organisations attracted most attention among the topics. In contrast, the discussions about family businesses and the age of firms did not resulted in much interaction between participants.

The discussion in Group 2 started with factors that the participants thought may affect decision-making in innovation. Factors mentioned in the discussions included customers (markets), quality of ideas, financial performance and capabilities (more about having the right people doing the right jobs). What was supported most was the importance of

considering ‘benefits’ (but not all about money) when making decisions. An example is shown in **Quote 4**.

> *Quote 4: “it's not always that sort of return this that money side of things we are… it's the business side of things that we to do something. That means it sometimes makes a business sense to something for the future.” (G3E)*

In this sense, that decision-making should be aligned with strategy was also mentioned. Linking this alignment with strategies, the potential harm of ‘trying to do too much’ was also mentioned in the discussion. The impact of culture and forecasting market demands was put forward, but it did not create much discussion. The discussion then moved on to how information is passed around. Examples of having meetings to collect information and provide feedback on employee performance were mentioned by participants. One issue identified in the discussion is that different functions within an organisation may ‘speak different languages’. This also means that these functions may have their own focus in daily practice, and it may be difficult to align them. Before the end of the discussion, more examples of how to engage employees were mentioned. Participants indicated that making employees feel what they do daily is part of innovation and can contribute to strategy is one way of motivating them.

Additionally, notes on the non-verbal communication in Group 2 showed the participants to be more interested in ‘decision based on benefits’ and ‘importance of involving employees’, with less interaction on ‘culture’ and ‘communication between functions’.

The discussion in Group 3 also started with what influence decision making in innovation processes. Common factors discussed included listening to customers and having a strategic roadmap. A few examples specifically focused on how organisations should decide what kind of idea to pursue were provided. Interestingly, this related back to the importance of identifying potential failures and giving up some projects timely. The discussion then moved on to the communication between marketing and R&D within organisations. One participant pointed out that the ‘return’ of innovation outcomes is not always ‘monetary’.

In terms of communication between different levels in organisations, the focus was on how to translate strategy top-down and also how to collect information that can help modify strategies bottom-up. This brought the discussion to building a structure for communication. One participant pointed out that this structure or procedure of communication is key when change is happening in an organisation. The final point touched on in the discussion was that

innovation outcomes may be generated anywhere in the organisation, so that every employee is important in the innovation processes.

With regard to non-verbal communication, all topics in this round led to interaction, especially during the discussion on listening to customers and building a structured communication within the organisation. There was no sign of negative expression or movements noted.

To sum up, the discussion in the third theme centred on key factors influencing decision making in innovation. Time, budget, benefits, and customer demands are factors that were mentioned frequently. These factors were also reported for the previous two themes. For communication, it seemed that some organisations have in place regular activities to collect information and provide feedback to employees. In terms of smaller organisations, they were working towards building structured communications as well. Table 7.6a, 7.6b and 7.6c present the initial coding based on these discussions. The codes are categorised into three main topics based on the discussion, these are: 7.6a about communication within organisations (during innovation processes), 7.6b on factors affecting decision-making in innovation, and 7.6c challenges in communication (during innovation processes).

Table 7.6a Initial Coding: Communication within Organisations

Codes	Quotation
Coaching sessions (need more)	· *I work in manufacturing and in terms of innovation, the processes etc. The team leaders have to uh hold coaching sessions just like twenty minutes with each employee. They all want to have a team of fifty people or. They can do this with the whole team you know the two or three times per weeks. uh basically coaching session is about uh so what you do today? Well I'm doing this process, so these are any frustrations and is there a better way to use?... This year the target is to encourage the team leaders to hold more of these sessions. (G1A)*
Motivate employees	· *You need to keep communication, tell them maybe something can happen and now as ways of motivating employee. (G1A)*
One-to-one meeting with line manager	· *We have one-to one session, you set objectives and those objectives are… during the one to one session between line manager and the individuals and talking about strategies, objectives, you know, make them think. (G1E)*
Regular updates	· *In terms of the communication question, I mean we do have uh quarterly updates for the whole company and basically there are strategy updates and things that can be communicated at that point. There a HR manager she runs regular group sessions with different groups of employees. (G1A)* · *We've just started, uh, every one of our locations has a monthly uh, health and safety meeting, which incorporates other business things as well. But it's focused mainly on health and safety. But we've introduced what are called strategy nudges, which is a power point of just two slides or just one of the strategic objectives. (G2E)*
Regular meeting for sharing ideas	· *They are structure and then within R&D in particular we have a regular stand up, just fifteen minutes for everyone to share what's happening. That's not really talking about the strategy or innovations. But this is particularly small talks about where we at with different things, but you know it's any topic of interest. (G1A)*

Codes	Quotation
	· *There's a wide variety of things depending on the project. We've brought in representatives from different functions to work together on a redesign of products to get feedback from the guys that build it in the factory. And the guys that are maintainers in the field, to get the two of them in the room together along with the designer and the project manager. Um, some really good ideas came out of that. And it's like you said earlier the simple ideas of the best ones. (G2E)* · *We have regular meetings with members of staff talking about stuff and gather ideas on a monthly basis. (G2A)* · *For manager line, if you're making something, you spent fifteen minutes which can use to describe what you're doing and for you to identify like… this is an automatic driver or what… This is what you work and basically where you want that small improvement would be also. (G3C)*
Between marketing and R&D	· *The problem for us used to be you know when marketing can come and talk, we have a target to sell this and another target to sell that. Then that was actually kind of filtering down, not trying to do everything at once, then based on their targets that can help our priorities as well. (G1A)* · *Probably a good communication between sales and R&D is important. Because you know every six months, they will see each other's ideal that this is what the customer wants and it's up to R&D to trying to develop it. So, building this road map together. Estimate between what the customer wants, and R&D may say we are not quite able to deliver or so. Sometimes they always wanted you to do in R&D project in a year which is just always ridiculous, and it never ever worked. And you always need to tell them from the start you need more time, but when you tell them at the start this will not be done, we can't do it. So, getting this on the same page. (G1D)* · *the sales guys promise stuff and it's like… we can't do that in 6 months, but you know that's two years' workload… and we've done it, has it made us much money? No… but we end up in a business that we did something. (G3E)*
Innovation hub	· *We have an innovation hub, for you with register your idea. And the idea can be sourced from their own department. It's not just in my department. But I will review the ideas and then discuss it with the others. (G1D)*
Specific group of people	· *I have a group of catalysts within the organization. They are like my team, although they don't work directly for me. They are my eyes and within the organisation. It works. They work in all areas of the organization, but they always come back to me. (G2C)*
Feedback on performance	· *So again, you tell them how they have performed. What is good in the performance and you give advice and such for how you get better next year. (G2A)* · *Say you have someone to get regular feedback form. We also collect their thoughts so that at some point you know they not engaged. But we give feedback on how it went last year what we do next. Yeah what they do and what to do in the next five years according to the plan. (G2A)* · *It's the mind-set, it's the human side… maybe that can be… it's the human behaviour that's really important, how to change your mind set. We've known people who don't mind change and you get towards… looking at the work they have done in the last few months. (G3A)* · *It's of what operator does day to day, not asking for is a description of what is doing, but rather on how they are doing it. (G3B)* · *They feel when they see the idea put into practice that can energize the workers the company. And they feel like a part of the product development progress. So, keep them up to dated. (G3A)*
Small organisations	· *We are really a small team and there's twenty-four of us or in communication and that's quite easy to console together pretty much because we so small. IT's quite easy for everyone to hear about how things are going and want what's have been successful and what has not been successful. (G2D)* · *Work in companies like start-ups… there is the flexibility on this. But these companies, the start-up problems, they discuss between themselves they can't change that. It may be hard when they start to grow a bit. (G3F)*
Constant updates on progress	· *An absolutely brilliant example in a factory in Czech Republic making compressors. There was a production line and the guys are working on the*

Codes	Quotation
	assembling the compressors and there was a big flat screen tv above the line that gave the matrix you know what percentage they were at(G2E)
Meeting for highlighting issues	· *In communication is key for highlight with any issues as well. We have this problem with the new product, and it turns out to be a few problems with supply chain. And good to talk about it. (G2F)* · *Communication is good for identifying problems. Sometimes we don't have the problems right now, but we may see some coming up because we do this and do that. So, everyone on the same page. (G2A)*
Innovation room	· *My last company creates a lovely room with fancy coaches and 3D printer and called it innovation room. You may have a lab, a research lab. But at least other people could visit. Like rob said when the French companies come here, they go up to the engineer will have to see how they're doing recently. (G3C)*

Table 7.6b Initial Coding: Factors Affecting Decision

Codes	Quotation
Market requirements	· *We now looking for business to set up in the states. We are delivering packages and. Can we move on the part of production when manufacturing in the UK and trying to get them up to the US standards? You make sure you reach the level of becoming a new key player and I can setup business in the American markets. This change of operations then is a result of changing for strategies. (G1E)*
Sell products	· *Initially we were very small company. How we make decision is depending on we like do whatever it takes to sell the next product. (G1A)*
Road map	· *What we are now is more careful and you're having proper road maps and things, so we started follow and clearer guide. (G1A)* · *We prioritise ourselves to develop that strategic road map. Any innovation has to be able to be that road map to develop the vision of the company. (G3C)*
Capability	· *Business is trying to do too many different things that people are one. They can't do everything and can't look at all the ideas. So, the need is to have maybe two of the ideas that can get developed from start to end in a timely manner. (G1E)* · *Organisational capabilities for me to make sure that we have the right people to do jobs. (G2A)*
Strategy driven	· *Sometimes ideas do get to dragon's dens and then people who know about more, for example from higher up, will not approve to do that because of strategic reasons and see so you mentioned strategy, that link to the strategy. (G1E)* · *For us it really comes from alignment turn into focus areas. IT's like a draw for financial performance, customer satisfaction, and the things we need to do… But really, we choose where we focus form how does that fit to a five-year strategic plan. (G2A)* · *We're now trying to be much more focused on what's in the strategy and how does the technical development relate to what's on the strategy. And the strategy would cover finance, customers, technology and people and processes. (G2E)* · *So now one you'll see a five-year plan and the sensible challenges we call it comes to do that. What we have done the last year, is it reasonable, and then this year we need to try to do the same amount. (G2F)*
Customer	· *The first most important factor for us, obviously is always the customers. (G2A)* · *We very much uh listen to the customers. We're trying to develop a product for the first time. We're looking at every customers' idea and then rating it. (G3B)*
Financial performance	· *Financial performance is important. We need to make the numbers to grow. (G2A)* · *The second priority will be to focus the innovation where the companies here making money to where the biggest empty bottle would be. (G3C)*

Codes	Quotation
Time to market	· *We need to be making sure that what we do is not being done already. We don't want to start working in this place and investing a lot of effort in something that is already being done elsewhere. (G2C)*
Value and benefits	· *You need to decide, based on certain criteria, the very least should be you know, what the benefits will be. (G2D)*
Novelty of new ideas	· *We're quite unstructured in this way. We're maybe better than we used to be. It used to feel a little bit like somebody had an exciting new idea and everybody got really picked up about it and suddenly you were all doing that rather than the previous things. (G2E)*
Return on the business side	· *It's not always that sort of return this that money side of things we are… it's the business side of things that we to do something. That means it sometimes makes a business sense to something for the future. (G3E)*

Table 7.6c Initial Coding: Challenges in Communication

Codes	Quotation
When company is growing	· *That's a real balance to all purpose. From small to grow, where's the balanced of including everyone and communicate and now to actually think about passing certain information around. (G1A)*
Can't keep regular meeting	· *Happy for if I can meet twice a year with the catalyst, not always easy. (G2C)* · *It's actually really difficult when people are spread all over the country is like you say getting them together twice a year would be a fantastic achievement. We struggle with that. (G2E)*
Uncertainty in reorganisation	· *Well, because we are reorganising at the moment, communication is crucial, so people don't get lost or upset basically. Because you know the reorganisation always creates uncertainty. We are very clear in communication. We are and it's always coming from the top and always opportunities for meeting people and to come in for sessions. (G2C)*
Different language between functions	· *It's a difficult thing to get the right communication. What else makes us difficult in communication is sometimes in functions you can almost talk a different language. Like he was from financial department and talking about numbers, sales talking about markets and manufacture and engineering can sometimes become very technical. So, understand each other, so that the communication actually make sense. (G2D)*
Voice not heard	· *We got this example, a guy brought up something recently, very good idea and we can see the benefit. But he says I said that three years ago and I said that to three other people… so there was no mechanism for collecting that before. At least he stopped being innovative because no one was listening. Having a procedure is going to help us, don't miss out on anything, at least we are trying not to. (G3C)*

7.5.5 Overview of Topics Discussed

Based on the results from the discussion in each subgroup, it appears that having three subgroups with participants of diverse background (see Subsection 7.5.1). Table 7.7 presents an overview on the topics discussed in the three subgroups under the three themes.

Table 7.7 Overview of Topics Discussed

Themes	Group 1	Group 2	Group 3
Innovation activities	· How 'keywords are reflected in managing innovation activities ➢ 'play' and 'experiment' linked to idea generation ➢ different emphasis of 'play' and 'experiment' in radical and incremental innovation · How to 'search' for ideas ➢ the importance of external linkages, (industrial networking and regional innovation systems) · Testing and selection of ideas · How selected idea can progress in innovation processes	· Relating 'keywords' to innovation activities ➢ the mind-set to make changes, ➢ discovery as a bottom-line of innovation processes ➢ risk-taking in refinements, ➢ searching for and execution on ideas · Selection of ideas based on benefits of innovation outcomes · Manage different types of innovation processes · Importance of customer feedback, · Benefits innovation outcomes bring · Lead time in innovation processes	· Reasons to innovate · Keywords: variation, experimentation and discovery ➢ innovation process itself means uncertainty · Benefits of innovation outcomes · Overall success as an outcome · Managing risks and impact of external factors (industry 4.0) · learning as important factor (learning from failure) ➢ Motivate employees after project fails · The importance of managing culture and people in innovation
Strategic considerations	· Strategic orientation ➢ being competitive ➢ becoming the leader in the industry · The choice between acquiring technology and grow technology organically · How to achieve strategy ➢ building innovation processes ➢ translate strategies into specific daily practices · Changes in organisations affected by external changes (e.g. industry 4.0 and technology evolution) · Change in strategy affect innovation ➢ how to manage this change ➢ involving employees dealing with changes	· Strategic orientation ➢ protecting intellectual property (IPs) ➢ being leader in sector ➢ competitiveness · Realise strategies ➢ translating overall strategies into specific priorities · Interactions with customers for potential directions ➢ the risk of focusing too much on the customer ➢ use feedback effectively from customers · Experience sharing between divisions in organisations	· Having innovation strategy aligned with the business strategy ➢ financial performance and cost · Two-way interaction between strategy and innovation ➢ strategic innovation mission ➢ Innovative ideas lead to new strategies · Influence of 'failure' in innovation processes and risk-taking ➢ the outcome of a 'smart kill' · Decision-making in innovation processes and activities · The importance of engaging and training individuals · Having an innovative culture

Themes	Group 1	Group 2	Group 3
		· Manage strategic changes ➢ difference between short-, medium-, and long-term strategical goals ➢ constantly evolving strategies ➢ engaging employees · Awareness of no need to do more in terms of innovation activities	
Communication in innovation	· Pass strategies on to the rest of the organisation ➢ coaching sessions for employees ➢ meetings about short-term objectives, ➢ regular meetings between different functions · How firms can survive longer · Communication in small organisations · Difficulty of communication between functions · Timely communication, key in managing innovation · Innovation hub ➢ collecting information ➢ making informed decisions · Importance of budget · Resources allocation to different innovation projects	· Factors affect decision-making in innovation processes ➢ customers (markets) ➢ quality of ideas ➢ financial performance ➢ capabilities ➢ benefits (not always monetary) · Alignment with strategy · Potential harm of 'trying to do too much' · Impact of culture · How information is passed around · Meetings to collect information and provide feedback on employee performance · Different functions may speak different languages · Engage employees in innovation ➢ recognition of their efforts	· Factors affecting decision-making in innovation processes ➢ listening to customers ➢ strategic roadmap · Decision on what idea to pursue · Identifying potential failures and giving up some projects timely · Communication between marketing and R&D within organisations · 'Return' of innovation outcomes (not always monetary) · Translate strategies top-down · Modify strategies bottom-up · Building structured communication ➢ key during strategic changes · Innovation outcomes may be generated anywhere in organisations ➢ every employee is important

7.5.6 Key Findings from Focus Groups: Interpreting Initial Codes

The previous subsections presented the results from the focus group discussion about three themes: (1) innovation activities, (2) strategic impact on innovation, and (3) decision-making and communication in innovation. Initial coding of the analysis is provided in the corresponding tables. According to the data analysis procedure (Section 7.4), these initial codes are not yet directly related to the main concepts of exploration and exploitation in this study. Hence, this subsection will provide further interpretations of these initial codes to generate key findings relating to exploration and exploitation. To support the comparison of findings with other methods used in this study in later chapters, findings from the focus group are numbered as **FG1-FG13**. These findings are presented followed by an explanation of how they were derived from the discussion in the focus groups.

FG1: There are innovation activities that cannot be solely defined as exploration or exploitation as defined by March (1991). For example, it is reflected in the group discussions that when undertaking the activity of 'selection' (a keyword for exploitation), risk or 'risk-taking' (a keyword for exploration) also needs to be considered. In this case, this activity cannot be defined as either exploration or exploitation, because it contains keywords from both concepts. Another example is about 'discovery', as it was identified being an essence in all innovation processes. It implies that all innovation activities should contain at least some discovery. If 'discovery' is absent, then an activity may not be viewed as innovation activities. Hence, there is no pure exploitation in practice.

FG2: Keywords used to define exploration and exploitation have different importance in different stages of innovation processes. It is mentioned in the discussions that the keywords of 'play' and 'search' seem to be more important at the early stage of innovation. Also, by definition, 'production' is crucial in the later stage. However, participants pointed out that innovation processes in organisations are not linear, because sometimes learning from failure and ending of certain projects may be the starting point of new ones. This means that the distinction of when there should be more exploration or exploitation (if they are actually intentionally managed) is impossible to identify in practice. The reason is that when innovation processes do not always start with a clear aim of explorative or exploitative outcomes. Hence, there seems no added value of having exploration and exploitation as separated constructs in managing innovation processes.

FG3: Some aspects of innovation activities cannot be explained by the notion of 'exploration and exploitation'. The finding is based on the additional keywords identified by the participants in the discussion that is difficult to explain based on exploration and exploitation. Take 'dealing with problems' as an example, it is hard to attribute activities that are based on solving problems using the exploration or exploitation dichotomy. In the context of innovation management, this can mean solving a problem from the customer or solving a problem that has become an obstacle in innovation processes. It still can be argued that if problem-solving can be based on exploration or exploitation. However, the distinction between explorative problem solving and exploitative problem solving is hard to make. This brings the same problem to the dichotomy of exploration and exploitation as innovation activities; therefore, it is not helpful to go on to find distinctions between definitions based on exploration and exploitation.

FG4: Individuals do innovation activities, but not exploration or exploitation. It is mentioned that the start of an innovation processes or new ideas can come from daily activities of employees. Innovation activities are undertaken by individuals in organisations, but they are not given specific instructions to do exploration or exploitation. This indicates that most of the time individuals involved in innovation activities may not be aware that they are doing exploration or exploitation. Therefore, exploration and exploitation as activities are not necessarily intentionally chosen by individuals.

FG5: Innovation outcomes are sometimes influenced by external factors but not exploration and exploitation. For example, innovation processes are influenced when organisations are responding or reacting to the requirements or needs from customers. Gathering these requirements or needs from customers seems like exploration by definition. However, evaluating the capability of the organisation to actually make sense of these needs and requirements for generating innovation outcomes appears to be exploitation. These two aspects often happen simultaneously, and thus, it is useless to make the distinction between exploration and exploitation here. Participants also mentioned the importance of being 'disconnected' from customers. This means that whenever eliciting needs from customers happens, viewing whether the organisation has the capability to fulfil the need follows. Hence, when considering external factors, the distinction between exploration and exploitation is still hard to be made.

FG6: For organisations, as long as the benefits from successful projects can cover the losses from failed ones, innovation outcomes are considered as overall success. This

finding can only be supported based on limited evidence from the discussion. It is implied that organisations are searching for an overall success in terms of innovation outcomes. Therefore, organisations may not be intentionally pursuing the success of either exploration or exploitation. Participants did not mention that how often exploration- or exploitation-based innovation outcomes are successful (maybe because they are not using the dichotomy in practice to define innovation outcomes); hence, organisations will pursue benefits instead of either exploration or exploitation.

FG7: There appears to be no strategy that is solely exploration or exploitation oriented. Linking back to Table 7.5a, the strategic objective of 'searching for alternatives' appears to better align with exploration, whereas 'searching for improvement' links to exploitation. However, 'searching for alternatives' still cannot be isolated with what the organisation already has, which requires exploration. Similarly, although not mentioned explicitly, 'searching for improvements' may also require knowledge new to the organisation, which means some exploration needed. Hence, as strategic orientation, it is difficult to distinguish exploration from exploitation.

FG8: Organisations do not have two separate process of exploration and exploitation for generating innovation outcomes. In the discussion, there is no evidence indicating that exploration and exploitation are two separated processes or require different processes. Also, when the participants talked about 'building a process and standardising a process (for innovation)', they refer to one process. This implies that there are no different processes within organisations specifically targeting either exploration or exploitation.

FG9: 'Dealing with failure' appears to be the reflection of exploitation in practice, but exploration still plays a part. Based on the group discussion, dealing with failure includes identifying potential failures, accepting failures and learning from it. This is similar to the logic of exploiting current knowledge for future improvements. However, the discussion did not provide more examples of the exact outcomes based on the learning from the failures. Therefore, the outcome may be new knowledge, which makes learning from failure an exploration. This means the activity defined as exploitation can generate exploration-based outcomes. Also, dealing with failure is not something organisations chose to do by intention, rather it is a reaction when failure happens. This means that even if learning with failure reflects exploitation in practice, it is unlikely that organisations will decide to increase or decrease the volume of this activity.

FG10: **Viewing from both external factors and internal factors, exploration and exploitation do not have an impact on changes in strategies**. Based on Table 7.6c, it appears that there is no evidence indicating organisations will make changes in their strategies considering exploration or exploitation. The only exception here is the statement from the participants on 'do not need to do more', which implies a change of strategic orientation based on the intention of decreasing exploration. However, there is no further evidence on how this strategy is actually implemented in practice. This is to say that it is not clear if in daily practice, this organisation has ruled out all exploration.

FG11: Regular communication within the whole organisation in innovation processes are aiming at sharing ideas and identifying problems. Although this is not directly related to exploration and exploitation, but this finding show that organisations are not looking for feedback on performance based on exploration or exploitation. Hence, there is no evidence supporting past performance on exploration- or exploration-based outcomes having impact on innovation performances.

FG12: Exploration and exploitation are not the key internal factors affecting decision-making in innovation processes. Referring back to Table 7.6a for factors affecting decision-making in innovation processes, there is no one factor that can be defined as exploration or exploitation. In the focus group discussion, one participant pointed out that in an unstructured setting, decisions may be made based on novelty of the idea. One may argue that this reflects decision-making based on exploration. However, because 'novel ideas' can also be generated by exploitation, it is the idea itself instead of the dichotomy of exploration and exploitation that is affecting decision-making. For decisions that are strategy driven, since there are no strategies solely defined as either exploration and exploitation (discussed in FG 7), it further supports that the dichotomy does not have impact on decision-making.

FG13: Key challenges in communication during innovation processes do not reflect the dichotomy of exploration and exploitation. From the discussion it appeared that challenges in communication during innovation processes are not specific to exploration and exploitation. This implies that exploration and exploitation are likely to be one process. Also, the challenges identified in the discussion cannot be solved by the notion of 'exploration and exploitation'.

7.6 Design of Interviews

After presenting the key findings from the focus group, this section will explain how interviews have been used in this qualitative study. The following subsections will detail the designs of the interviews, including the interview protocol, sampling, and data collection and analysis in this part of the qualitative study.

7.6.1 Integrating Interviews with Focus Groups

Aligned with the design of this qualitative study (Subsection 5.8.5), additional interviews have served mainly the purpose of cross-checking findings from the focus groups and adding new insight to them. Similar to the focus groups, the design of the interviews is also based on **Research Framework 2**. This framework provided guidelines for developing the interview protocol and influences what data has been collected (see Subsection 7.6.2). The findings from both methods will be compared, but because focus groups will be treated as the primary method, more attention will be paid to the findings from the focus group.

The ideal situation in this design was to have multiple interviews from different companies that are included in the samples from the quantitative part of the study (Subsection 6.4.1). The focus group participants should also include representatives from this group of companies. However, for practical reasons (details on these reasons are presented in Appendix II), the ideal design could not be achieved in this study. Eventually, three interviews with only one organisation in the sample of 112 were conducted (see Subsection 7.6.3). Nevertheless, the focus group study was conducted among participants not from the companies studied in the quantitative part of the research (Subsection 7.3.4). Whether this current design was sufficient to support the purpose of the qualitative part of the study will be assessed after the final outcomes (this assessment can be found in Chapter 8).

7.6.2 Developing Interview Protocol

This study selected semi-structured interviews as the method for data collection. This is because semi-structured interviews are more flexible for generating new insights and getting participants to talk freely (Saunders et al., 2016, p. 391). Based on Research Framework 2 (see Subsection 4.4.6), an interview protocol was developed prior to conducting the interviews (Castillo-Montoya, 2016). The interviews included four parts: (1) innovation activities, (2) making decisions in innovation processes, (3) strategies for managing innovation, and (4) process and systems of innovation. Cross-checking with the purpose of

this qualitative study, these four parts could address research question 2 (see Subsection 5.9.1).

7.6.3 Sampling for Interviews

The sampling for interviews was based on the 112 companies analysed in the quantitative part of this study. This is to make sure that a comparison can be made between the performance evaluation using data envelopment analysis and the internal innovation processes of the specific company. Requests on conducting interviews were sent out, and as a result, company B2 agreed to participate in the study. However, this was the only access to a company was granted. For company B2, interview was conducted with the general manager, an operations manager and a senior engineer in the company. These three participants are all involved in processes such as new product development, in their daily jobs, and therefore, are suitable for the interviews. Also, their different role in the organisation provided diverse perspectives on innovation.

7.6.4 Conducting the Interviews

This subsection will discuss the data collection and analysis for the interviews. Using interviews as a data collection method has been thought and approved by the ethical community of the Collage of Social Science, University of Glasgow; see Appendix VII for details for ethical approval. The interviews were conducted face-to-face, 90 minutes with the general manager, 45 minutes with the operations manager, and 45 minutes with the senior engineer. Prior to each interview, a participant information sheet was provided, and signed consent forms collected. This provided permission for all three interviews being audio recorded. The researcher also took notes during the interviews. These audios and notes are the data collected from the interviews. In terms of data analysis, analysing data from interviews is similar to focus groups (Section 7.4).

7.7 Results from Interviews

This section will present the results and findings from the interviews based on the main themes included in the interview protocols (Subsection 7.6.2); main findings will be demonstrated for each theme. Each subsection will first show what has been discussed in the interview, and then present the key findings with explanation of how this study arrived at them based on the data analysis. Also, findings from interviews will be labelled as **IN1-IN9**.

7.7.1 Innovation Activities

The purpose of the theme 'innovation activities' is to investigate whether there will be activities in the organisation that can be defined purely by keywords March (1991) used to conceptualise exploration and exploitation. Based on their understanding on what 'innovation' means, the three interviewees talked about how they see innovation activities in practices. Since there are differences between positions, their perceptions on innovation activities have shown different foci. These differences were shown in aspects of production and design (for example, see **Quote 5**), changing and discovery, and dealing with customer requests.

> *Quote 5: "As a designer, your primary job is to get the thing done. Um, you know, you've got the performance time cost triangle. Um, cost doesn't really matter to me wasn't design it. Performance does, and time does… change into the production side, that performance cost time triangle slightly changes, where you do actually need to think about cost." [Engineer]*

Despite different views of innovation activities, all interviewees mentioned that people are the key in innovation activities, aligned with FG4 (Subsection 7.5.6). Furthermore, because people are different, getting to know people and making sure the right people are doing the right job may be one of the most important issues in managing innovation processes and for achieving innovation outcomes. Overall, the data collected under this theme of innovation activities has led to three main findings.

IN1: Keywords that are used to define exploration and exploitation are reflected in innovation activities, but there is no evidence that there is an activity that can be defined purely as exploration or exploitation. For example, when talking about developing new products that are relying on 'discovery', the interviewees referred this to 'planned discovery'. This means that even when activities may look like exploration, there will still be elements of exploitation involved. This is also the case for exploitation. In the interview with the general manager, it is mentioned that sometimes when the organisation is trying to make improvements to a certain product (exploitation by definition), sometimes there is a need to search for new solutions that require new knowledge to the organisation. Hence, in activities that appear to be exploitation, exploration is also needed.

IN2: Innovation activities and processes in some cases cannot be explained by the notion of exploration and exploitation. This is especially the case when interviewees were describing innovation activities based on solving problems. Since solving problems may rely

both on existing knowledge and searching for new solutions, it will be difficult to categorise these activities as either exploration or exploitation. The same applies to innovation processes; this will be discussed in Subsection 7.7.3.

IN3: One of the key factors of managing innovation processes and achieving innovation outcomes is people. This then requires companies to understand differences between people, identifying different skillsets in people and allocating the appropriate people to the right task. This implies that exploration and exploitation may be a consequence of different ways of doing things by different people. For example, in the interview with the engineer, it is mentioned that when facing a new technical problem, he usually turns to the knowledge the organisation already has for solutions. When the existing knowledge does not solve the problem, he then instead goes on searching for new knowledge. For a different person, this problem may be solved in a different way. Thus, whether the outcomes of certain activity are achieved by exploration and exploitation, it is just a reflection of how different people are dealing with certain tasks. As reflected in IN1 and IN2, these tasks however, are not specifically exploration- or exploitation-oriented.

7.7.2 Decision-making in Innovation

The theme 'decision-making in innovation processes' aimed to examine whether the dichotomy exploration and exploitation influences making decisions during innovation processes. Three types of decisions have been discussed with the interviewees, namely (1) decisions on what projects to undertake, (2) decisions on prioritising resource allocation to different projects, and (3) individual decisions on what tasks to perform. The general manager and operations manager have mainly talked about the first two types of decisions, whereas the senior engineer mentioned how individuals may manage time and decide what kind of tasks to pursuit; this is also mentioned in IN3.

For factors affecting the selection on what projects to do, customer needs, value and benefit to the company, market and potential growth, and external knowledge have been mentioned by the interviewees as factors affecting decisions on what projects to undertake. In terms of resource allocation, both the general manager and the operations manager indicated that resource allocation is often dependent on strategic importance or priority of projects. In some cases, resources are allocated to the projects that are closer to completion, as indicated in **Quote 6**.

> *Quote 6: "(in prioritising projects) if something is near to being in the market that will suck up all the resources… so things accelerate as they near launch date. Um, and then of the other projects that are near launch date, it will be down to a strategic decision made by CTO and the divisional directors… often the products are part of a bigger system. So, if the rest of the system isn't going to be ready when we are planning to be ready, that will obviously lower the priority. However, if the rest of the system is waiting for us, then that will increase the property to super urgent… the last thing we consider is from key customers." [General Manager]*

For decisions made by individuals, the senior engineer mentioned that this is depending on time management. As people have different ways of working and skillsets, they should have the freedom to choose what to focus on as long as they can fulfil their daily duties. Overall, the discussion in this theme has generated two main findings.

IN4: Exploration or exploitation do not influence the selection of projects by an organisation. The logic behind this is that the organisation will not choose to start certain projects because they are exploration or exploitation. This is because the criteria the organisation uses may be the benefits that lie in the core of a project portfolio. Customer needs and external knowledge may often be starting points for projects, but it is not specifically linked to neither exploration nor exploitation.

IN5: The dichotomy of exploration and exploitation is not used for allocating resources to different projects. This is similar to the discussion on IN4. There is no evidence showing that the organisation will allocate resources to projects because they are either exploration- or exploitation-based.

7.7.3 Processes of Innovation

The focal point in this theme 'process of innovation' is on whether exploration and exploitation are regarded as separated processes for practices of innovation management. This can also be reflected on whether exploration or exploitation can be accomplished without each other. During the interviews, the common understanding was that product development projects, no matter targeting new product development or product improvements, are based on the same process. The operations manager mentioned that the company is also working on standardising this process for all projects, to make product development more efficient. The general manager summarised that the difference between types of product development projects lies in the depth of using different tools, as indicated in **Quote 7**.

> *Quote 7: "Team would be different because of different skills needed… we would run the current products development or new product development in the same process… (these projects) using the same tools, but to different depths" [General Manager]*

The interviewees also mentioned that their organisation is implementing changes in product development process. Instead of having a stage-gate-based process, the organisation now wants a more flexible process based on 'problem solving', as indicated in the **Quote 8**.

> *Quote 8 "We are in the process of moving away from traditional stage-gate towards a more systems engineering approach, which is much more likely, much more agile and comprehensive… this is more about requirements, can be a lot of things, right requirements, comprehensive requirements, we are then focusing on these requirements, meet or solve them" [Operations manager]*

To sum up, the interview under this theme has pointed to one finding.

IN6: Exploration and exploitation are not found as two separated processes in practice. This is clearly indicated in the interviews. There is only one established product development process in the organisation, indicating no separated processes exist for exploration and exploitation.

7.7.4 Communications in Innovation processes

The part of interviews around the theme 'communications in innovation processes' aims at understanding whether past performance based on criteria of exploration and exploitation influences managing innovation processes. At the same time, it aims to see how exploration and exploitation are reflected in the information flow. This means how information is passed on in innovation processes. The interviewees mentioned that their company is trying to communicate during innovation close to the state of 'live updates', ensuring timely responses to potential problems. In terms of the influence from past performance, the general manager indicated that the criteria they considered mainly are market related. The operations manager confirmed this point and added that past performance is also important for gaining knowledge to be used in new projects, as indicated in **Quote 9**.

> *Quote 9: "We are doing certain product for years and we are leader of this technology. Sometimes yeah, you have a success and then there may be a theme, a family of products from it… so see these opportunities, can lead to different things" [Operations manager]*

In some cases, a successful project may create 'themes' for a number of new projects, which are not necessarily incremental or radical. As indicated in **Quote 10**.

> *Quote 10: "When you have one innovative product, project, that is successful, sometimes there is a family of it, philosophically or technological let them to go together and go well in later project. If we develop another product it would actually stand on the shoulders of the previous product. There is a theme here. We can reuse that and that can lead to another project, so all become part of a family." [Operations manager]*

Interviewees also touched upon the topic of dealing with failure and stated that it is often that failures that can potentially be a starting point for some breakthroughs. Overall, the discussion under this theme can be categorised into three main findings.

IN7: There is no evidence that the organisation will intentionally manage a 'balance' between exploration and exploitation. Linked to discussion in IN4, there is no evidence showing that the organisation will decide to start for example an exploration-based project just because they have too many exploitation-based projects.

IN8: Breakthroughs may result from failures. As discussed in FG10, 'dealing with failure' seems to reflect exploitation in practice. However, it is mentioned in the interviews that breakthroughs, which are often associate with exploration, can also be an outcome of dealing with failures. This further supported that it is hard to make a distinction between exploration and exploitation in practice.

IN9: The two focal points of communications in innovation are feasibility and expected benefits of certain project. Interviewees mentioned that marketing departments are often involved in the early stages of innovation processes. This is to make sure that products developed can be commercialised to become innovation outcomes. These two focal points do not reflect exploration and exploitation.

7.8 Summary of Findings

Based on the findings from both the focus group and interview-based data collection, the qualitative part of this doctoral study has demonstrated how exploration and exploitation are reflected in practices of innovation management. This includes: (1) activities, (2) strategies, (3) processes, and (4) decision-making. This section summarises these findings from the focus groups and interviews. The first subsection will discuss exploration and exploitation

in practice, followed by the second subsection focusing on refining the research framework based on the findings.

7.8.1 Interpretation of Exploration and Exploitation

The findings from the focus groups and the interviews have provided evidence for this study to make sense of exploration and exploitation in practices of innovation management. Linking back to the discussion in Subsection 3.7.2, previous studies have defined exploration and exploitation as different activities, processes or strategies in practices of innovation management. First, with regard to activities, findings FG1, FG2, and IN1 have pointed out that it is difficult, or even impossible to identify a certain activity as either exploration or exploitation based on the keywords March (1991) used to conceptualise the two concepts. These keywords in practices of innovation management are often associated with each other, making it difficult to further distinguish exploration activities from exploitation. In addition, findings FG3 and IN2 indicated some aspects of innovation activities that are hard to be explained by the notion of exploration and exploitation, for example, innovation activities based on problem solving. Findings FG9 showed that 'dealing with failure' may reflect exploitation in practice, however, this is still having a certain degree of exploration (IN8). Hence, there is no evidence supporting exploration and exploitation being distinct innovation activities in practice.

Second, in terms of processes, findings IN6 and IN7 clearly indicate that organisations do not have different processes for exploration and exploitation. Finding FG8 also hints that organisations may be looking for standardising processes for product development. Therefore, with considering the notion, there is no empirical evidence that supports the conceptualisation of exploration and exploitation as different processes in managing innovation. Last, FG7 indicated that organisations may not be formulating strategies based on exploration and exploitation. Finding FG6 further supported that organisations are searching for an (overall) success instead of being exploration- or exploitation-oriented. As a result, the findings do not support exploration and exploitation being defined as different strategic orientations in practice.

As it is difficult to define exploration and exploitation in practice, the findings also indicated the fact that organisations may not intentionally control or manage exploration and exploitation. This argument can be support by looking at two aspects. First, exploration and exploitation are having no influence on on-going decision making. For factors mentioned in

both focus group discussions and interviews that are affecting decision making in innovation processes, FG10, FG12, IN4 and IN5 all indicated that decisions were made influenced by internal and external factors, which cannot be defined as exploration or exploitation. In other words, organisations will not make decisions based on the consideration of the dichotomy of exploration and exploitation. Second, past performance on exploration and exploitation has no influence on the selection of future innovation projects. Past performance of exploration and exploitation, whether they have led to success or failure, is often treated as source of knowledge for next projects. This is supported by finding IN4 that indicates organisations are pursuing value and benefits created by innovation outcomes instead of searching for a balance between exploration and exploitation. Hence, organisations are not using exploration and exploitation as criteria for managing innovation.

To sum up, the findings from the qualitative study did not provide any support for the separation of exploration and exploitation in practices of innovation management. Linked to Table 7.1, Table 7.8 categorises the findings to further demonstrate why this separation is not supported. As a result, these findings indicate that the notion of exploration and exploitation may not be valid in the context of innovation management.

Table 7.8 Linking Findings to Deducted Phenomenon

Phenomena	Linking to Results	Related findings
• (In a certain time period) there will be activities or processes in an organisation that can be classified as only exploration or only exploitation ➢ Activities based on keywords that involve in exploration can be successful without key words from exploitation, and vice versa	No evidence supporting pure exploration or pure exploitation as innovation activities	FG1, FG2, FG3, IN1, IN2
• Organisations are aware and will try to control exploitation and exploration	No evidence supporting this intentional management of exploration and exploitation	IN4, IN7, FG13, FG14
• When making decisions, organisations will have sufficient information about the outcome of the decision ➢ When decide to do exploration, they will only expect new knowledge without expectation on improving existing knowledge, and vice versa	Organisations will have expectations about benefits of certain decisions made, regardless whether new or existing knowledge is in play	FG6, FG10, FG13
• When an organisation decides to search for knowledge completely new to them, they do not need existing knowledge at all, and vice versa	Was not clear based on the findings	N.A.
• There will be a clear plan within an organisation to allocate resource for either exploration or exploitation	Exploration and exploitation have limited impact on resource allocation	IN5
• Resources that are allocated on exploration will never result in outcomes related to exploitation, and vice versa	Was not clear based on the findings	N.A.
• No serendipity exist in innovation processes ➢ All new products and/services/processes/business models are developed by an identifiable group of people that are aiming to 'develop new products/services/processes/business models' ➢ All improvement made on terms of existing product/service/process/business model are developed by an identifiable group of people that are aiming to 'improve exist product/service/process/business model'	Accidental discoveries are hinted at during the discussion, but no specific example given. Also, individuals are given the freedom to focus on different tasks.	IN6, IN8

7.8.2 Refining Research Framework

In addition to the evidence gained for understanding exploration and exploitation in innovation management practices, the findings have also contributed to a refined version of the theoretical framework in this study. Specifically, the findings from the focus group and the interviews have contributed differently to the framework. Findings from the focus group have mainly contributed to the specification of the overall structure of the framework. For example, focus group discussions have identified a step of 'specifying strategies' between strategy formation and portfolio management. This means that organisations will break an overall strategy into specific objectives and pass them on to the whole organisation. In addition, findings are valuable to further describe how the information flows in the framework, and clarify feedback mechanism. In terms of interviews, the findings have provided a different view on 'resource allocation and configuration' based on 'problem solving'. Combining the findings allows this study to arrive at a refined version of the research framework, presented in Figure 7.1.

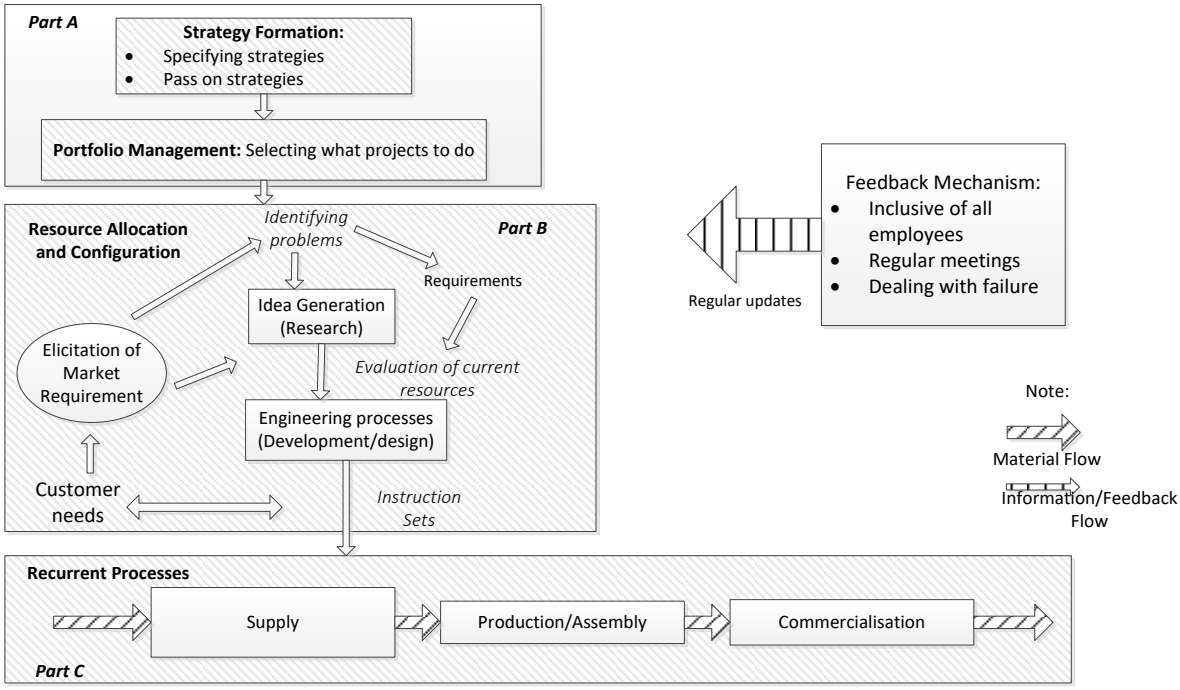


Figure 7.1 Refined Framework Based on Findings

7.9 Summary of Chapter 7

This chapter presented the qualitative part of this study that relied on a focus group supplemented by interviews. Detailed designs of the focus group and interviews were provided, including their sampling, data collection and analysis. The results and findings presented in this chapter have provided evidence on the use of the dichotomy of exploration

and exploitation in practices for innovation management, contributing to addressing the research objectives of this study. Key points in Chapter 7 are as follows:

- The qualitative aspect of this study is based on **Research Framework 2**, where no pre-set definition is given for exploration and exploitation.
- The focus group discussion consists of in total three subgroups. Three rounds of the discussion took place based on three different themes. Participants for the focus groups were recruited through a business network.
- Three interviews were conducted in one of the organisations identified as ambidextrous based on the results from DEA discussed in Chapter 6.
- The interview protocol and themes for focus groups were developed guiding data collection. Data analysis was based on two cycles of abstraction.
- Focus groups have provided 13 findings whereas interviews led to 9 findings.
- These findings suggested that exploration and exploitation are not viewed as separated in practices for innovation management.
- In addition, these findings provide refinement to the research framework.

Combined with the findings from the previous Chapter 6, this study is able to provide answers to the research questions in the next chapter.

Chapter 8 Amalgamating Findings and Discussion

8.1 Introduction

The aim of Chapter 8 is to combine the quantitative (Chapter 6) and qualitative (Chapter 7) parts of the empirical study for the overall findings of this study, and thus, provide answers to the research questions. Therefore, this chapter will start by discussing the added value of having data envelopment analysis, focus groups and interviews, and how the combination of the three methods lead to the final empirical outcomes of this study. Section 8.3 has a further discussion on the findings compared to the extent literature and assumptions of the dichotomy. This then allows Section 8.4 to discuss how this study may address the four research questions stated in Section 4.3.

8.2 Added Value of Combining Three Methods

This section aims to give an overview of the findings from the three methods used, and based on it, to see how the combination of these methods contributed to the research aim of this study. Figure 8.1 presents how the three methods are related to each other. With the combination of focus groups and interviews already discussed (Section 7.8), the following subsections will demonstrate how data envelopment analysis is linked to the two qualitative methods and make a comparison between their findings. The last subsection will offer a amalgamation of the three methods.

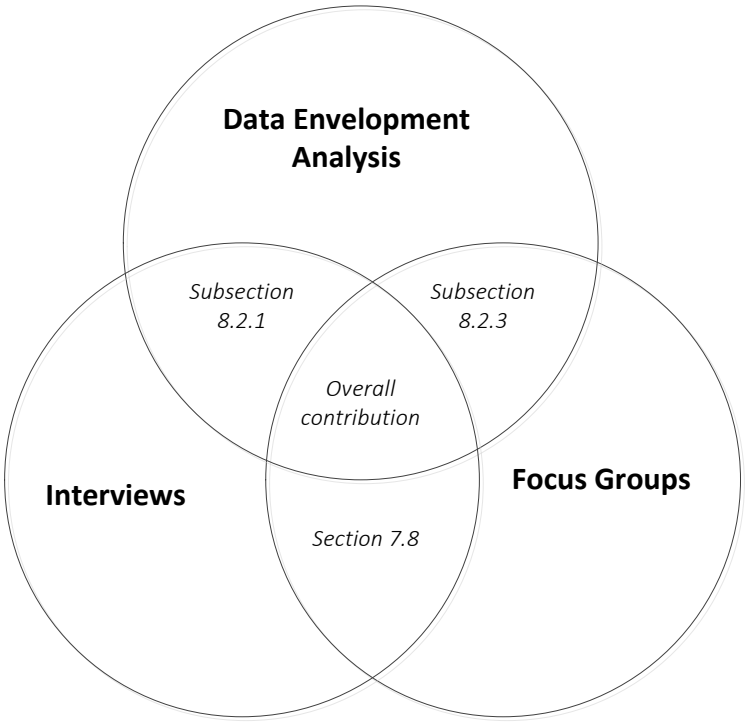


Figure 8.1 Amalgamating Three Methods

8.2.1 Data Envelopment Analysis and Interviews

The direct link between data envelopment analysis (DEA) and interviews is the sampling for interviews (for the latter, see Subsection 7.6.3). Three interviews were conducted from one of the 112 organisations studied in DEA, allowing a direct comparison of the findings between DEA and the interviews. Based on finding DEA1 (Subsection 6.7.1), the organisation participating in the interview was identified as ambidextrous (i.e. efficiency score=1). Nevertheless, findings IN4, IN5 and IN7 all pointed out that there was no evidence demonstrating specific practices for managing exploration and exploitation (Subsections 7.7.2 and 7.7.3). This implies that although exploration and exploitation can be used as evaluation criteria, these are not considered by organisations in practices for innovation management. Thus, becoming ambidextrous is not a target that organisations aim to achieve.

8.2.2 Data Envelopment Analysis and Focus Groups

The link between the focus group and data envelopment analysis (DEA) is shown implicitly in the design of the focus group. Before the group discussion took place, there was a 20 minutes presentation introducing the topics and key terms like ambidexterity (Subsection 7.3.5). This presentation contained an overview of how DEA was conducted together with its results. The purpose of this presentation was to see if participants were familiar with the conceptualisation of ambidexterity, whether they will consider themselves to be ambidextrous and discuss related topics. It turned out that participates barely touched upon the distinction between exploration and exploitation (Subsection 7.5.5). Participants were less interested even in relevant topics about radical and incremental innovation (see Subsection 7.5.2). Because of this indirect link between the two methods, it is hard to make a direct comparison between their findings. One point to note here is that finding FG6 suggests that for evaluating performance organisations are aiming at benefits rather than being ambidextrous in managing innovation (Subsection 7.5.3). Also, there is no evidence found in the focus group that support the use of exploration and exploitation as evaluation criteria in practices for innovation management. Hence, combining the limited 'joint evidence' of DEA and the focus group, it appears that ambidexterity is not a concept that practitioners use in practice is further supported.

8.2.3 Overview of Findings

The amalgamation of the three methods allowed this study to obtain relatively comprehensive evidence in its investigation of exploration and exploitation. The

comprehensiveness of the outcomes from the empirical investigation lies mainly in two aspects. First, using three methods supported this study to cover both external (with specific focus on industry level) and internal level of analysis. By looking at both levels, investigating exploration and exploitation both as criteria and as managerial practices was possible. In addition, a comparison of the two levels of analysis was also possible. The outcomes of this comparison support **Argument 1** (Subsection 4.2.3): *"If exploration and exploitation can only be defined based on outcomes of activities or processes, then the dichotomy is only helpful in evaluating past performance, whereas not being used in managing future innovation because it has no impact on managers' on-going decision making."* Second, the investigation focused on the dichotomy itself, which means direct evidence on the use of the notion of exploration and exploitation in practice. Consequently, the outcomes of this study pointed to no evidence of using exploration and exploitation in practice; the definition of exploration and exploitation as activities, strategies or processes have all been examined (see Subsection 3.3.2). Consequently, this sustained **Argument 2** (Subsection 4.2.3): "*The dichotomy of exploration and exploitation are not very helpful in aiding managerial practices.*" In the next section, these findings will be discussed relating to the literature for further insight.

8.3 Discussion of Findings

This section provides further discussion of the overall findings. The first subsection relates the findings of this study to the literature, aiming to provide further explanations to the dichotomy of exploration and exploitation. The second subsection refers back to Subsection 4.2.2 and uses the empirical evidence from this study to revisit the postulations, domain and background assumptions of the dichotomy.

8.3.1 Linking Findings to Literature

As indicated in Subsection 8.2.1, the organisation that was identified as ambidextrous from data envelopment analysis did not have a specific practice in place for managing exploration and exploitation. This means that becoming ambidextrous as such may not be teleological to or an ambition of an organisation. This understanding contradicts claims made by studies that becoming ambidextrous is what organisations purse (e.g. Chandrasekaran et al., 2015, p. 580; Karhu et al., 2016, p. 16; Voss and Voss, 2012, p. 15). Therefore, the organisation may not realise that they are ambidextrous, and not consider the frontier based on the dichotomy of exploration and exploitation. These findings have led to challenges put on the

focus of some existing studies about ways to achieve ambidexterity. Here, if becoming ambidextrous is not by the choice of organisations, then there is the possibility that organisations can become ambidextrous without adopting specific managerial practices specifically to exploration and exploitation.

By its definition, ambidexterity can be considered 'correct'. However, being able to identify ambidextrous organisations does not necessarily mean ambidextrous will be related to internal practices. Hence, it appears that exploration and exploitation are treated separately in previous studies because they are constructed to be distinguished. The empirical findings in this study, which had no pre-set definition for exploration and exploitation, did not find support for this distinction in practices for managing innovation. This conjecture contradicts previous definitions of exploration and exploitation related to internal practices of managing innovation in organisations (Subsection 3.7.2); the findings from this study do not support exploration and exploitation being conceptualised as activities, processes or strategies in practice. One logical explanation from previous literature is to associate exploration with product innovation and exploitation with process innovation (e.g. Bauer and Leker, 2014; Kodam and Shibata, 2014). However, this is not the common way of conceptualising the dichotomy, and there does not seem to be added value in defining exploration and exploitation this way.

Based on the result, it appears that the findings from this study may be better explained by the concepts of dynamic capability. In the seminal paper of Teece et al. (1997, p. 516), dynamic capabilities are referred to as "*the ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments*". Have dynamic capability means the organisation should constantly view current resources and responding to changes accordingly in practices for innovation (Breznik and Hisrich, 2014). Linking to the findings, this is similar to what participants have mentioned on elicitationing requirements from customers and having a standardised process for developing products in place (see Subsections 7.5.3 and 7.5.4). Dynamic capabilities have been used to explain ambidexterity in management studies (Subsection 3.5.4), but not in the context of innovation management. For example, in their case studies about globalisation, Vahlne and Jonsson (2017) categorised ambidexterity as a part of dynamic capabilities.

Based on the understanding of dynamic capabilities, the discussion around 'dealing with failure' in focus groups and interviews are similar with studies that emphasise the importance of 'mistakes' and that they may lead to future opportunities (for instance, Danneels, 2008,

p. 542; Williams, 1998, p. 72). The findings have also pointed to basics of 'problem-solving', which corresponds with the research of Nickersson and Zenger (2004), and von Hippel (1994). However, it has been pointed out in O'Reilly and Tushman (2008, p. 196) that the dynamic capability may be a useful way to conceptualise ambidexterity, but they did not provide a clear description of such. Therefore, this is merely adding other terminologies into the discussion. As a result, further evidence may be needed to provide more insight into these theoretical aspects. This study remains in doubt that dynamic capabilities are the answer to the problems regarding the dichotomy of exploration and exploitation.

The importance of individuals in managing innovation has also been recurrent in the data (Subsections 7.5.2, 7.7.1 and 7.7.2) and findings (FG4 and IN3). This is aligned with previous studies that are focusing on analysis of individuals within organisations (e.g. Karhu et al., 2016; Nemanich et al., 2007; Zacher et al., 2016). The idea of being inclusive to employees in innovation is alike to the claims of contextual ambidexterity. Here studies have argued that organisations can create a context that is supportive for integrating both exploration and exploitation (see Subsection 3.4.6 for a detailed discussion on contextual ambidexterity). However, based on the premise that the consequence of ambidexterity is not by choice of the organisations, the 'context' from contextual ambidexterity can be identified, but there is no evidence showing that this context is created for enabling the balancing between exploration and exploitation. Hence, this makes the arguments based on the concept of contextual ambidexterity self-evident.

8.3.2 Linking Findings to Assumptions

With regard to the dichotomy itself, the dichotomy of exploration and exploitation has been viewed assumptions and further specified to the three levels of postulations, domain, and background assumptions as a start (Subsection 4.2.2). Here, these three levels of assumptions will be revisited based on the findings. Examinations of the postulations on the dichotomy is mentioned in Subsection 7.8.1. The findings did not support the phenomenon derived from the postulations, meaning that the postulations are not valid in practices for innovation management. Considering background and domain assumptions, data envelopment analysis treated exploration and exploitation as different criteria and used clear conceptualisation. This means that the part of the background and domain assumptions that exploration and exploitation can be clearly and consistently defined as two theoretical constructs is true. However, based on the findings from the qualitative study, there is no evidence supporting that the dichotomy of exploration and exploitation are useful and considered by

organisations in practices of innovation management. This not only means that definition of exploration and exploitation are not consistent, but also indicated that exploration and exploitation are not be observed as two practices. Without looking at other management disciplines, it can only be concluded that the domain assumption underpinning the use exploration and exploitation as separated constructs in the context of innovation management is not valid, and that this dichotomy should not be implemented in studying practices of managing innovation.

8.4 Addressing Research Questions

With the domain assumption sustaining the dichotomy of exploration and exploitation proven to be not valid, this section will explicitly address how the four research questions (Section 4.3) were answered based on the findings from the empirical study.

8.4.1 Research Question 1

The first research question in this doctoral study is: '*how to identify organisations that manage exploration and exploitation efficiently?*' This was addressed through first defining exploration and exploitation as criteria, then measuring and benchmarking efficiency of organisations using data envelopment analysis. Based on this, ambidextrous organisations were identified with a focus not only on the quantification of outcomes, but also on inputs for R&D (Subsection 4.4.5).

Notably, this approach is different with previous studies that are outcome-based (e.g. He and Wong, 2004; Jansen et al., 2005). Ambidextrous organisation identified through this method is no necessarily related to the actual quantity of inputs and volume of outcomes of R&D. This is to say that organisations restricting input or possessing low value of outcomes from R&D can also be identified as ambidextrous. However, this does not mean that the actual values for outcomes are not important, instead, emphasis is put on how organisations may generate these outcomes efficiently. This then emphasis the internal processes of organisations related to innovation, helping to link the quantitative findings with the qualitative ones (Section 8.2). Being able to identify ambidextrous organisations does not mean it makes sense or is impactful in practice. To sum up, using DEA is beneficial in identifying ambidexterity; the usefulness of this performance evaluation still relies on answers to the second and third research questions.

8.4.2 Research Question 2

The second research question to be addressed is: '*how does performance in terms of outcomes and resource allocation in the context of ambidexterity influence on-going decision-making on innovation management?*' The comparison between the findings from DEA and the interviews provided insight to answering this research question. Formulating this research question in another way, it explores whether ambidextrous organisations have 'ambidextrous managerial practices'. To obtain answers to this research question, some key features of ambidextrous organisations identified through DEA were confirmed through its additional validation study (Subsection 6.6.1). Similar to what has been discussed in literature, all ambidextrous organisations identified have shown both the ability of being innovative and profitable (Subsection 6.6.4).

This then led to the investigation of internal processes for managing exploration and exploitation that enables an organisation to be ambidextrous. Based on the results from the focus group and interviews, the notion of exploration and exploitation has limited impact with regard to on-going decision-making during innovation processes (Subsection 7.8.1). This is supported by the fact that factors affecting decision-making in innovation processes that were often brought up during the qualitative part of this study are not be explained using exploration and exploitation (see FG10, IN2). In addition, the results suggest that ambidexterity is not something that organisations intentionally pursue. This is because there are no specific practices for managing exploration or exploitation found in the ambidextrous organisation investigated (see Subsection 7.7.2). It appears that the factor 'benefits' lies at the heart of how organisations are making decisions during innovation processes (Subsection 7.5.2).

As a result, the answer to this research question is that ambidexterity may not be by choice. Past performance on exploration and exploitation can be evaluated, but this evaluation does not act as a major concern when organisations are making decisions during innovation processes. Nevertheless, organisations do seek for benefits or growth through innovation, but the notion of exploration and exploitation is not considered for finding answers to this problem.

8.4.3 Research Question 3

The third research question intended to establish: "*what are the practical treatments of exploration and exploitation in managing innovation, and are they treated separately to the*

extent assumed by March (1991) in practice?" Findings from the focus group and interviews have provided direct evidence reflecting exploration and exploitation in practice. Different from the definitions used in previous studies (Subsection 3.7.2), the findings in this study however, show no empirical evidence supporting exploration and exploitation as being separate activities, strategies or processes in innovation management (Subsection 7.8.1).

The keywords that March (1991) used to conceptualise exploration and exploitation were regarded as important in innovation activities and processes (Table 7.6a). However, it is difficult to solely identify exploration or exploitation using these keywords. Because no matter innovation activities or processes, it is impossible to make a distinction between exploration and exploitation; discussing them separately is not helpful (Subsection 7.5.2). Exploration and exploitation are not something that organisations have certain practices in place for.

In terms of resource allocation, where March (1991) believes the choice between exploration and exploitation lies, this dichotomy did not play a role as well (see IN5). This is to say that organisations will not allocate more or less resources to a project because it is considered to be exploration or exploitation. As a result, this study argues that explaining innovation management based on the notion of 'exploration and exploitation' may not be comprehensive, and thus not very helpful applying it. This means the answer this study propose to this research question is that March's (1991) dichotomy of exploration and exploitation is not appropriate to use in the context of innovation management, because the postulations (1991) is not supported by the data; in addition, the domain assumption underpinning the dichotomy are proven invalid (Subsection 8.3.2).

8.4.4 Research Question 4

The last research question of this doctoral study reads: "*how innovation management could be understood if exploration and exploitation are not separated in practice?*" The answers to the previous three questions have indicated that the notional separation of exploration and exploitation in innovation management practice is not valid. By thinking exploration and exploitation not being separated, this study means that not appropriate to use this notion to explain innovation management. An alternative way of understanding innovation can be found in the refined **Research Framework 2** presented in Subsection 7.8.2. This is also related to problem solving in the context of innovation management. Referring to dynamic capability, the nature of innovation could be understood as a process of identifying

'problems', finding solutions to the 'problems' and solving the 'problems'. Besides looking from a 'problem solving' perspective, since innovation is often treated as different projects, practices from project management can also be a valuable perspective. However, the empirical evidence in this study is only sufficient for pointing to new directions (see Section 9.6 for directions for future researches). To make further contributions to understanding innovation through these new perspectives; additional research is certainly needed.

8.5 Summary of Chapter 8

This chapter provided an overview of the findings from the empirical parts of the study, combined findings from quantitative and qualitative parts, and addressed the four research questions. Overall, the key points discussed in this chapter are as follows:

- The combinations of the three methods used contributed to new insight for this study.
- The overall findings contradict existing studies in exploration and exploitation but provide a relationship to other theories such as dynamic capabilities.
- The dichotomy of exploration and exploitation is proven to be not valid in practices for innovation management. This is because the postulations and domain assumptions sustaining the dichotomy are not supported.
- For research question 1, data envelopment analysis provided a useful way to identify ambidexterity. However, this evaluation does not necessarily make sense for managerial practices.
- For research question 2, being ambidextrous did not influence on-going decision-making in practices for innovation management.
- For research question 3, exploration and exploitation do not seem to be intentionally managed in practice.
- For research question 4, innovation can be understood not based on the notion of exploration and exploitation, but from the perspectives of problem-solving in the context of innovation management and project management, it can be more accurately explained.

Chapter 9 Concluding Remarks

9.1 Introduction

This chapter presents the outcomes, scholarly contributions and limitations of this study. Accordingly, Section 9.2 reviews the research process throughout this study and its outcomes. Section 9.3 discusses the contribution of this study to scholarly knowledge, whereas Section 9.4 covers the implications for practice. This concluding chapter ends with Section 9.5 addressing the limitations and Section 9.6 showing directions for future research.

9.2 Summary of this Study

The summary of the research process in this study includes its outcomes from both the literature review and the empirical part of the study. This then leads to the discussion of the contribution in the next sections and to see whether it has achieved what it set out to investigate in the beginning.

Interested in the recurrent notion of exploration and exploitation in studies about managing innovation, an in-depth investigation into the dichotomy in the context of innovation management was conducted. Conceptually, it was proven that the dichotomy of exploration and exploitation is based on assumptions that have not been verified in innovation management related literature. This was supported by a systematic approach to the literature review (see Chapter 3). The outcome of the literature review suggested that the assumed notional separation of exploration and exploitation as proposed by March (1991) requires further examination. In addition, it appears that this necessary examination has not received enough attention from current studies into innovation management, and that exploration and exploitation have been taken for granted and applied as different perspectives; for instance, perspectives on ambidexterity; see Section 3.4 for full descriptions on these perspectives. This lack of examination is also supported by an evaluation of previous research methods used by studies. With survey-based design being a more favourable method in previous studies, there is limited ‘direct evidence’ provided to sustain the dichotomy of exploration and exploitation; see Subsection 5.2.3 for a detail discussion on limitations of previous research designs.

The doubts and questions that arose from the literature review helped to delineate the problem of interest and formulate four research questions for examining the validity of exploration and exploitation (Section 4.3). To address these questions two research frameworks were built looking for alternative explanation of managing innovation; see

Subsection 4.4.4 for **Research Framework 1** and Subsection 4.4.6 for **Research Framework 2**. The findings from empirical data indicated that the distinction between exploration and exploitation in innovation management practice is hard to make. Furthermore, organisations may not be using the scholarly constructs of exploration and exploitation for guiding innovation management.

These outcomes have empirically demonstrated that the dichotomy of exploration and exploitation is not practically valid for innovation management. As a result, moving away from this notional separation should lead to a more inclusive framework for the management of innovation processes that are embedded in organisational processes and structures. This new framework is also presented as one outcome of this study, although more empirical evidence may be needed for certain aspects; see Subsection 7.8.2 for this framework based on findings from qualitative research. Overall, these outcomes demonstrated that this study has achieved its aim and has made both theoretical and practical contributions.

9.3 Contribution to Scholarly Knowledge

Drawn from the outcomes summarised in the previous section, this doctoral study contributes to discussions around the notions of exploration and exploitation and the broader innovation management domain. The overall outcomes have demonstrated a divergent between theoretical conceptualisation and actual practices. It has then led to two contributions to scholarly knowledge. For the notion of exploration and exploitation the contributions lie in testing 'theory'; although the dichotomy of exploration and exploitation should be viewed as an assumption, not a theory. This testing has also been leveraged towards building insight in innovation management towards theoretical conceptualisation. The following two subsections will discuss in more detail how this study has made a contribution to scholarly knowledge based on both theory testing and building.

9.3.1 Contribution to Exploration and Exploitation

First, this study contributes to testing the conceptualisation of exploration and exploitation in innovation management. Different from the existing perspectives in the literature, it is shown both theoretically and empirically that the dichotomy of exploration and exploitation is merely an assumption and is not valid for practices of innovation management. Thus, the outcomes form a clear challenge to the original proposition of March (1991), and his dichotomy of exploration and exploitation.

Also, perspectives based on exploration and exploitation used by scholars were further questioned. Existing perspectives (Section 3.4) are all based on taking exploration and exploitation as separate constructs. The outcomes from this study indicate that studies based on the notional separated exploration and exploitation are measuring a theoretical notion that does not exist in actual practice. Moreover, it is discovered that the conceptualisation of exploration and exploitation is not used for decision-making in organisations for practices of innovation management. Table 9.1 provides an overview of the contribution relating to different perspectives in studying exploration and exploitation. To sum up, the contribution to the discussion around exploration and exploitation has been made by contradicting the validity of the implication of this dichotomy for the domain innovation management.

Table 9.1 Contribution to studies of exploration and exploitation

Perspectives	Key Studies	Contribution
Classical trade-off	Bauer and Leker (2013); March (1991);	• Exploration and exploitation are not separated and should not be treated as a trade-off between two extremes of dichotomy. • Resource allocation is determined by expectations about the eventual outcomes of specific activities that exploration and exploitation cannot explain.
Temporal ambidexterity	Carlisel and McMillan (2006); Mudambi and Swift (2011)	• The (strategic) shift of focus by organisations is mainly determined by external factors such as customer demand and internal factors like strategic orientation. • Organisations may be observed as performing activities in the context of exploration and exploitation, but this is not determined by their intentional control of the two.
Structural ambidexterity	Benner and Tushman (2003, 2015); Tushman and O'Reilly III (1996)	• The allocation of resources to different units may be helpful based on different characteristics of different innovation projects. • The establishment of such unit should be based on the need for specific projects instead of generic classification into exploration and exploitation.
Contextual ambidexterity	Gibson and Birkinshaw (2004); Lin et al. (2013)	• A supportive context could contribute to successful innovation. This may contain the inclusion of employees, an open culture and a positive attitude towards failure. • This context is not for the purpose of sustaining or balancing exploration and exploitation; alternative explanations may be needed for such 'organisational context'.
Paradox	Andriopoulos and Lewis (2009, 2010); Papachroni et al. (2015)	• Arguments for managers to build up capabilities sustaining competitive strategies is supported. • Exploration and exploitation should not be understood as a paradox, because it appears not to be a consideration for the organisation in making decisions.

9.3.2 Contribution to Innovation Management

Second, the contribution to scholarly knowledge is also shown in providing a direction for theory building in studying innovation management. As indicated in the findings, in practice there are two possible ways for viewing innovation management. The first is through the basics of 'problem solving'. Here, delineating the term 'problem' can be broader to cover more aspects of innovation management. For example, this 'problem' can mean customer requirements or a need to achieve certain strategic objectives. Second, managing innovation can (sometimes) be regarded as managing innovation projects in practice. Hence, relevant discussion around project management may be viewed as a direction of building theoretical perspectives for scholarly knowledge of innovation management.

A further integration of these two possible directions is also shown in the refined **Research Framework 2** and presented in Subsection 7.8.2. This provided a relatively comprehensive explanation of practices for innovation management. However, due to the limited evidence gained from the empirical part of the study, new directions may still need more support from further studies. This will then be discussed further in Section 9.6. As a result, this study has contributed to innovation management by providing a new perspective and a direction for building theory.

9.4 Implications for Practice

Besides these two contributions to scholarly knowledge, the outcomes also have implications for practice. Notably, the main purpose of this study was to test a theoretical notion. Therefore, the main implication for practice lies in the results of testing. It appears that because this study has provided proof that the dichotomy of exploration and exploitation is not valid in practice for innovation management, the practical implications indicated in previous studies should then be reconsidered. Previous studies proposing implications for practice based on the notion of exploration and exploitation should not be followed blindly. Managers should carefully consider whether treating exploration and exploitation separately actually contributes to better management of innovation. The mind-set of managers should be changed to think that both exploration- and exploitation- based activities (if they can be defined at all) can contribute to innovation and may be co-determined. Hence, this should not be ignored in strategic planning and decision making. This is considered as the main practical implication.

In addition to the main implication, implications for practice can also be suggested based on different empirical methods used. Findings from on data envelopment analysis offer implications for practice in two aspects. First, it provides a way that managers can use to benchmark their organisations within a given context. The context could be their sector, market domain or region. This not only applicable to understanding the benchmark of their organisation within the sector, but also helpful to understand the position of their competitors. Second, results of DEA provide an estimation on how to become ambidextrous, by taken into consideration their own organisations' states. It could be beneficial for managers to decide whether to focus on making changes in the input (in this case it means R&D expenditure) or finding ways to be more effective of generating more output (here it refers to patents).

Findings based on the focus group and interviews suggested an inseparable view of exploration and exploitation. This demonstrates a different way of conceptualising innovation in the research framework. This more inclusive framework for the practices of innovation management can be combined with existing innovation process in organisations (as shown in the research framework). The inseparable view of exploration and exploitation is expected to reduce organisational conflict in team building, strategic goal setting, and management decision-making. However, to make a more significant contribution to practice, more empirical evidence and support may be needed to refine and further specify the research framework.

9.5 Limitations

Considering that this is likely the first attempt to challenge the notional separation of exploration and exploitation, this doctoral study is not without limitations. Generally, this study has limitations in the quantitative part, the qualitative part, and the overall research design. Nevertheless, addressing these limitations may lead to a valuable future research agenda. The following subsections will discuss these limitations in detail and provide some directions to address them.

9.5.1 Quantitative Part of Study

Considering a capability-based approach, this study only considers exploration and exploitation as R&D capabilities using limited variables. Although an additional validation has been included, due to the time and constraint resources available for the research, there

are limitations from mainly three aspects: (1) data used, (2) model developed, and (3) validation approaches. However, as a first step of adopting this approach, this study proposes to consider these limitations as part of the 'trial and error' processes.

The limitation in terms of data used consists of three main points. First, patent counts have been the only data source in data envelopment analysis. Patent data has long been recognised as insufficient in measuring innovation, since it is an indirect indication for innovation outcomes (e.g. Adams et al., 2006). Thus, using patents as the output of R&D may not be capturing the process comprehensively enough. Alternatively, literature-based innovation output indicators, which were for the validation, could provide more accurate results to DEA. Due to the time restriction, this study was not able to implement this to DEA. Second, sectors have been used as context; however, the data is not significant enough to examine the impact of context. This is because due to the data requirements of DEA that all organisations in the sample must have reported patents; organisations that were missing data in the selected year were removed from the sample. Since DEA results relied on the context, in this case, the sectors, these removed organisations may have had better performance that could affect the final outcomes of the analysis. Third, the measurements for radical and incremental output were reduced to only to be based on self-citation of patents. A matrix that can evaluate the quality or novelty of patents could provide more accurate measure for the output. Viewing these limitations from an overall study point of view, having different and more measurements will change the results of DEA. However, based on the purpose of the quantitative study, it is not likely to change the main finding (DEA1) of the analysis.

Regarding the model used, this study only used a simple abstraction of the R&D capability. It should be noted that the current model may be extended to include two aspects. First, the final classification and measurement implemented implies a classical trade-off perspective for exploration and exploitation. It is believed by this study that the relationship between exploration and exploitation is rather complicated, hence, it may be helpful to introduce more input and output measures to better demonstrate this relationship. Possible items may include R&D personnel at the input side, and patent quality at the output side. Second, defining exploration and exploitation based on other relevant capabilities can contribute to forming overall innovation capability, for example, as marketing capability regarding how organisations could commercialise innovation outcomes. This may lead to the use of multi-stage DEA models. Similar to the limitations about measurements, improving the research model may lead to the identification of different organisations that are on the frontier. Here,

the main finding DEA1 would remain the same, not affecting the overall outcomes of this study.

The limitations of the validation study for DEA concerns mainly two aspects. First, due to the data collected and analysed, it is not possible to make seamless comparisons between the 18 companies used within the sample. This may reduce the validity and cause lacking some valuable insight on how the outcomes from the R&D process are actually transformed into innovation outcomes. Second, considering propositional logic, it is likely that there might be type I errors in the validation. This means that without the time and resources to apply this validation approach to all 112 organisations and not able to compare them using the additional data, there may be organisations besides the identified 18 in the validation study being ambidextrous as well. However, DEA has already created a wider scope of identifying ambidexterity. The validation study did support that the 18 companies identified by DEA are ambidextrous, this is sufficient for comparing the findings from DEA with the qualitative part of the study.

9.5.2 Qualitative Part of Study

In terms of the qualitative part of this study, limitations mainly appear due to the limited access as a doctoral student to organisations. First, more interviews from companies in the sample of DEA could provide more insight and stronger evidence to address the research questions. This could also led to single or multiple case studies that could better enable possible comparison among: (1) ambidextrous organisations, (2) no-ambidextrous organisations and (3) ambidextrous and no-ambidextrous organisations. Second, because the focus group participants did not include personnel from organisations in the sample of DEA, the link between focus group and DEA may be weaker, and therefore, could make it difficult to directly compare the findings from these two methods. Third, the sampling of focus group did not take 'industry' as a factor into consideration. This is to say that the participating organisations in the focus group discussions were in different industries than the organisation with which the interviews were conducted. As a result, the perception on innovation may be influenced by industrial contexts, which is not captured by this study. However, there is no significant difference noted on this aspect based on the data collected. Last, because of the focus and design of the research, this study still lacks evidence to fully support **Research Framework 2**. This may require a multiple case study design. Viewing innovation from 'problem solving' or possibly a 'project management' perspective requires a different research focus. This may be more suitable for future research. These limitations on sampling

and design may affect the overall outcomes of this study, because there may be an organisation in the sample that actually has a set of practices for exploration and exploitation, thus, making this dichotomy observable in practice. However, based on how innovation activities and processes are reflected in the data collected, this study argues that this is unlikely to be true.

9.5.3 Overall Research Design

There are three additional limitations in the overall research design. First, this study has only used UK companies for its data, which means that the study did not consider the possible impact from the regional context. Here, one factor that may impact how practitioners see exploration and exploitation could be national culture. Second, although the quantitative part of the study based on DEA looked at exploration and exploitation based on industrial level, it still lacks consideration of external factors. Here, external factors refer to relationships such as competition or collaborations among organisations. The lack of consideration of external links may result in an inaccurate explanation of exploration and exploitation in innovation management. This is to say that there may be certain contexts where exploration and exploitation are treated separately in innovation management. This then requires further investigation in addition to this study.

9.6 Directions for Future Research

Having covered the limitations of this study, the discussion will move on to discussing some directions for further research that can be built from this study. Specifically, the first direction for future research lies in further investigation into viewing innovation based on ‘problem solving’ or ‘project management’. Further studies should build on the framework for innovation proposed in this study and aim at providing more empirical evidence for it. As mentioned in Subsection 9.3.2, this will contribute to building theories for innovation management.

Second, after addressing the limitations of its research design, a similar design logic to this study could be replicated in future research. The use of ‘Pugh’s controlled convergence’ method in research design has proven its novelty. This could be considered for research design processes in the future. In addition, further studies could develop and rely on a more comprehensive framework for data envelopment analysis (DEA) and conducting a multiple-case study based on the performance evaluation results from DEA. This also brings up the

possibility of using regions as context for the analysis and allowing consideration of differences in national cultures.

Third, future research could take relationships of organisations into account, and investigate whether competition and collaboration of organisations affects exploration and exploitation in innovation. This could then also be linked with discussions and studies in areas such as strategic alliances.

Last, this validation of the notional separation of exploration and exploitation could be extended into other management disciplines such as strategic management and marketing management. Since this study only focused on product innovation in the empirical study, as a starting point, investigations into service, process and business model innovation may also be beneficial. As indicated in Subsection 2.3.2 and presented in Appendix I, the dichotomy of exploration and exploitation may also be problematic in these management disciplines. It is necessary for further studies, both theoretically and empirically, to first view exploration and exploitation as assumptions, and focus exclusively on justification of the notion before moving on to implications. Therefore, this can act as a reminder to management studies for the necessity of consulting other theories and being open to alternatives in dealing with phenomena that occur managerial practices and terms appearing in academic studies.

9.7 Closing Remarks

This study is the first attempt of providing validation to a popular theoretical notion in innovation management. To do so, this study provided evidence supporting its arguments. It concludes that the dichotomy of exploration and exploitation is only an assumption, and it is not valid for building theories in innovation management. Notwithstanding some limitations, the outcomes of this study achieved what it aimed to do. The treatment of exploration and exploitation as separate constructs in practice for innovation management is examined and not supported by the research findings. Therefore, this study contributes to the discussions of exploration and exploitation. Based on this understanding, alternative ways to view innovation were also provided, which contribute to both scholar knowledge and managerial practices in innovation management.

Appendix I: Brief Review of Exploration and Exploitation in other Management Disciplines

Exploration and Exploitation in Organisational Learning

Studies in organisational learning have paid attention mainly to three aspects. First, studies have discussed ways to balance exploration and exploitation. For example, Russo and Vurro (2010, p. 41) argued that the balance can be achieved by organisations that focus on internal exploitative learning combined with external explorative network. On the contrast, Fang et al. (2010) proposed that this balance can be achieved by creating subgroups in organisations that focus on different types of learning. Second, studies have considered what factors may have impact on managing exploration and exploitation. These factors include but are not limited to knowledge management initiatives (Filippini et al., 2012, see page 318 for definition of the term), competitive intensity as moderating factor (Auh and Menguc, 2005, see page 1654 for definition of the term) and relationship learning (Wang and Hsu, 2014, see page 332 for definition of the term). Third, studies have results discussing the relationship between managing exploration and exploitation, and performance. For example, van Deusen and Mueller (1999, p. 190) supported that the interaction between exploration and exploitation, which in their measure means having a high level for both constructs, has a positive impact on acquisition performance. Contrastingly, in the study by Li et al. (2010, p. 1193) a 'high-low' combination between exploration and exploitation has a positive impact on new product development performance, which they argued is prove for the need of a trade-off. To sum up, it seems that although the 'interaction' between exploration and exploitation learning has been mentioned several times in studies on organisational learning with results from studies to suggest the benefit of this 'interaction', the conceptualisation of these two types of learning is still based on the original propositions by March (1991) that are challenged in this study.

Exploration and Exploitation in Strategic Management

Generally, exploration and exploitation has been discussed mainly in two topics under strategic management literature. The first topic is focused on managerial activities internally to the organisation, whereas the other topic considers external activities such as acquisition and strategic alliance. This section will first discuss how exploration and exploitation is conceptualised in the context of strategic management and moving on to a brief overview of how these two concepts are studied under both topics.

For the conceptualisation, exploration and exploitation are often defined as either strategic orientation (e.g. Ireland and Webb, 2007; Lin et al., 2007) or managerial activities (e.g. Ireland and Webb, 2009; Nielsen and Gudergan, 2012) in strategic management literature. Similar to the original definition in organisational learning, exploration is associated with searching and absorbing broad knowledge for competitive advantage, whereas exploitation refers to searching for in-depth knowledge and leverage these knowledges in the market (Ireland and Webb, 2009, p. 472). Despites similarities has shown in defining exploration and exploitation into consideration, there are also attempts for developing different ways of interpreting the dichotomy. Piao and Zajac (2016, p. 1444) argued that exploitation might impede and impel on firms' subsequent exploration activities in the long term and this impact is dependent on how exploitation activities are conducted in managerial practice. In supplementing this argument, they defined two different types of exploitation, where repetitive exploitation means that firms re-uses existing designs and incremental exploitation refers to creating new designs on existing products. Similar to the original definition from March (1991), Siren et al. (2012 p. 20) categorise exploration as opportunity seeking and exploitation as advantage seeking; the results of their study suggested that although both strategies can have a positive impact on performance, exploitation in the short-term is negatively related to exploration. In contrast, Adner and Levinthal (2008, p. 51) proposed that all activities are inherently exploitative in their nature so that behaviours be called explorative can be better understood as *"exploitative activity on a dimension of performance not currently accepted or recognised"*. Based on their definition, it seems that there is no need to conceptualise exploration. It is notable that most of these ways of defining exploration and exploitation shares the same ground with the original definition except for the proposition by Adner and Levinthal (2008) that shed light to the interactive nature in exploration and exploitation, which can be considered as a step forward in understanding the two constructs. This 'interactive nature' has raised further doubt in what exploration and exploitation the actually is, a doubt that not being further picked up in current studies

With the conceptualisation of exploration and exploitation in strategy management discussed, attention will now be paid to what has studies on managing exploration and exploitation strategically within organisations been focused on. There are studies taken the perspective that managers should make decisions for either exploration or exploitation. For example, the study from Posen and Levithal (2012, p. 599) argued that by adapting to a turbulent environment, organisations should make decisions to shift towards an exploration-orientated strategy rather than emphasising a balance between exploration and exploitation. Differently, Molina-Castillo et al. (2011, p. 1180) proposed that the decision to focus more

on exploration or exploitation is dependent on the target of the organisation in terms of new product development with a distinction made between achieving high quality or innovativeness. On the contrary, studies have discussed how organisation can balance the strategic emphasis on exploration and exploitation activities instead of making choice on either one. For example, the concept of strategic entrepreneurship has been proposed as a useful way for balancing the two activities (see for example, Ireland and Webb, 2009). Similarly, Kauppila (2010, p. 307) proposed that a desirable balance can be achieved through structurally separated 'interorganisational' partnerships. This means that organisations can create separate unites that enable exploration or exploitation but at same time maintain a strong link between these units. Nevertheless, no matter what ways studies have proposed to balance exploration and exploitation, it seems that these ways are based on the interpretation that the key issue in managing exploration and exploitation is the inevitable tension between the two.

In terms of managing exploration and exploitation externally to organisation, studies have focused on two main topics. First, studies have looked at how organisations should choose or balance exploration and exploitation. Similar to managing exploration and exploitation internally within the organisations, there have been debates on whether making choice to focus on one of them or finding ways to have a balance of both is the beneficial thing for organisations to do. In terms of making choices, Nielsen and Gudergan (2012, p. 560) argued that exploration and exploitation are separate strategies and that organisations should make decision to use either one or another based on consideration of in factors such as partner experience, competence similarity, culture distance and partner trust. Taken a similar stand, Lambe et al. (2009, p. 259) proposed that cooperative competency will influence organisations to choose an exploration strategy in alliance formation, whereas complementarity has an impact on organisations choosing an exploitation strategy. As whether organisations should find balance between these two strategies, the study from Lavie and Rosenkopf (2006, pp. 813-814) suggested that in alliance formation, organisations tend to make balance in the function domain (which is referred to as network structure in their study) and that behaviours in balancing exploration and exploitation over time from organisations is shown. To be more specific, one of the evidences they provide to demonstrate this behaviour is that in strategic alliance, the proportions of R&D and marketing agreements are almost the same. In addition, the study from Lin et al. (2007) proposed that firms do benefit from balancing exploration and exploitation in alliance formulation, especially when the environment is considered uncertain measured by volatility of the net sales of all firms. Second, studies have provided support for the impact of

managing exploration and exploitation on performance. For example, in the study from Nielsen and Gudergan (2012) exploration and exploitation are in nature conflicting strategies and that simultaneously pursuing both strategies will have a negative impact on international strategic alliance performance. Besides, Lin et al. (2007, p. 1656) argued that although large organisations are often searching for the balance approach, the impact of such balance does not always lead to economic benefits. It seems that this argument is a bit vague because it is not clear what the 'balance approach' is and of course none of the managerial can guarantee economic benefits. In contrast, Stettner and Lavie (2014, p. 1924) argued that the performance of an organisation will be enhanced if they implement exploration externally and exploitation internally. To be more specific, this is means organisations should looking for partners to share the risk of exploration externally and focusing on exploitation in managing the organisation internally. To sum up, it seems that there has not yet been an agreement on the overall impact of balancing exploration and exploitation in performance.

Exploration and Exploitation in Marketing

There will be three main topics to look at: (1) conceptualisation of exploration and exploitation in marketing, (2) the main foci of studies and (3) outcomes of studies in this discipline. Starting with how exploration and exploitation is defined in marketing studies, there are studies that relied on the original definition and applied exploration and exploitation as marketing learning activities. For example, Zhang et al. (2015) defined market exploration as searching for new knowledge or skills outside of the organisation's current product market, whereas exploitation as about refine current knowledge and skills in organisations current product market. This definition is on the way of defining in organisational learning studies with the learning or searching is discussed under the marketing context. Other studies have taken a more 'capability-based' view and conceptualise exploration and exploitation as marketing capabilities that specifically related to how well an organisation can manage explorative and exploitative learning in marketing practices (Vorhies et al., 2011; Ho and Lo, 2015). There are also studies (e.g. Kyriakopoulos & Moorman, 2004) that define the two concepts as different marketing strategies and conceptualise exploration as strategies that challenges existing market segmentations, positioning and channels, whereas exploitation strategy as improving existing market segmentations, positioning and channels. Based on the definitions discussed above, conceptualisation of exploration and exploitation in marketing management have shown few adjustments to the definition to fit the context of marketing, but except for this closer relation to markets, there is little difference with the original definitions in organisational learning.

Taken into consideration similarities of the conceptualisation in marketing compared to other management domains, it would be expected that the studies reveal no additional justification of the dichotomy of exploration and exploitation. In fact, similar to other domains, studies in marketing management have focused on how to manage exploration and exploitation and the impact on performance. First, in terms of how to manage, Kyriakopoulos & Moorman (2004, p. 234) argued that a market-oriented organisation can and should be pursing for high levels of both exploration and exploitation. Similarly, Zhang et al. (2015, p. 306) proposed that organisations can better manage both exploration and exploitation by constantly assessing customer needs and knowledge. Contrastingly, Vorhies et al. (2011, p. 750) argued that it is risky for a customer-oriented organisation to maintain a high level of both exploration and exploitation. This is based on the understanding from March (1991) that exploration and exploitation will compete for resources and trying to have a high level of both capabilities cause organisations to divert the focus of resource allocation. Second, regarding the impact on performance, Zhang et al. (2015, p. 306) found that the 'join effect' of exploration and exploitation will reduce the speed-to-market and have no impact on innovativeness of products. This possible negative impact has also been supported by the study of Ho and Lu (2015), and Vorhies et al. (2011). On the contrary, Hoang and Ener (2015, p. 17) supported that applying exploration sequentially to exploitation will improve organisation's market performance. This is aligned with the results from Kyriakopoulos and Moorman (2004) that organisations with a strong market orientation will likely benefit for their performance by balancing exploration and exploitation. Overall, similar to other disciplines, how to better manage exploration and exploitation, and the impact of these practice on performance in the context of marketing is still in doubt.

Appendix II: Part of Literature Review Spreadsheet

Authors	Year	Research Method	Level of Analysis	Postulations of March (1991) referred						Reference to Key articles		
				A1	A2	A3	A4	A5	A6	March (1991)	L&M (1993)	March (2016)
Yang & Li	2011	Survey, questionnaire, quantitative	Organisation				x	x	x	x	x	
Knight & Harvey	2015	Longitudinal, single case study in a global media organisation, qualitative	Individual/ micro process	x	x		x			x		
Geiger & Makri	2006	Longitudinal secondary data, Panel analysis, quantitative	Organisation		x		x	x		x		
Glising & Nooteboom	2006	Secondary data, use one industry as case study, descriptive, qualitative	Sector		x			x		x	x	
Quintana-Garcia & Benavides-Velasso	2008	Survey based, using of Patent data, quantitative; Exploration is measured by patents that have no citations to others p.498	Organisation		x			x		x	x	
Hernandez-Espallardo et al.	2011	Questionnaires, survey based, quantitative	Organisation	x	x	x			x	x	x	
Kim et al.	2010	Longitudinal patent data analysis, quantitative; self-citation is been regarded as exploitation, citation of other source is exploration	Organisation					x		x		
Blindenbach-Driessen & van den Ende	2014	Longitudinal, survey based, secondary, quantitative	Organisation	x	x	x		x		x	x	
Bauer & Leker	2014	Time-lagged cross-sectional objective data, secondary, quantitative	Organisation (business unit)	x	x	x	x			x	x	
Matzler et al.	2013	Online survey among CEOs; quantitative	Organisation	x	x	x	x	x		x	x	
Garcia et al.	2003	System dynamic modelling'; simulation; model based on two case studies	NPD process (decision making)			x	x	x		x		
O'Reilly & Tushman	2004	Case study (sort of)	Organisations		x							
Greve	2007	Secondary data, longitudinal, quantitative	Organisations		x	x	x	x	x	x	x	

Papachroni et al.	2015	Conceptual	Organisation	x	x	x	x	x	x	x	x	
Gibson & Birkinshaw	2004	Kind of mixed, interview+survey, reported only the quantitative part, the design and question itself seems more quantitative orientated	Business-unit		x		x	x		Only as an example		
Chang & Hughes	2012	Survey, questionnaire, quantitative, measurement from Jansen et al. 2006	Organisation		x			x	x	x	x	
McNamara & Baden-Fuller	2007	Event study method, that's new, 'assess the reaction of the financial markets to announcements, secondary	Organisation				x	x		x	x	
Jansen et al.	2009	Survey based, different level of managers, measurement from Jansen et al. 2006, quantitative	Organisation	x	x		x	x		x	x	
Benner & Tushman	2003	Conceptual	Organisation		x			x		x	x	
Wei et al.	2014	Survey based, measurement of E/E from Atuahene-Gima & Murray, 2007, quantitative	Organisation			x		x		x	x	x
Mudambi & Swift	2011	Secondary, quantitative	Organisation		x	x		x		x	x	x
UN	2007	Conceptual	Organisation	x	x	x	x			x	x	x
Andriopoulos & Lewis	2009	Comparative case study	Organisation		x		x	x	x	x		
Jansen et al.	2005	Survey based, quantitative, they developed measurements themselves p. 355	Organisation (business unit)		x			x		x	x	
Bierly at al.	2009	Interview + survey + secondary, but mainly quantitative	Organisation		x			x		x	x	x
He & Wong	2004	Survey based, developed own measurements, quantitative	Organisation	x		x	x	x		x	x	
Cesaroni et al.	2005	Multiple case studies, four cases each present one type of R&D strategy	Organisation			x	x					
Voss & Voss	2013	Survey based, use qualitative methods for building measurement for E/E (focus group)	Organisation			x	x	x		x	x	x
Groysberg & Lee	2009	Secondary, quantitative	Individual		x		x	x		x	x	
Tushman & O'Reilly III	1996	Conceptual	Organisation				x			x		
Visser & Feams	2015	Survey based, questionnaire, quantitative; measure from Mom, said to be measure E/E on individual level	Between Individual and organisational level	x	x	x	x			x	x	x

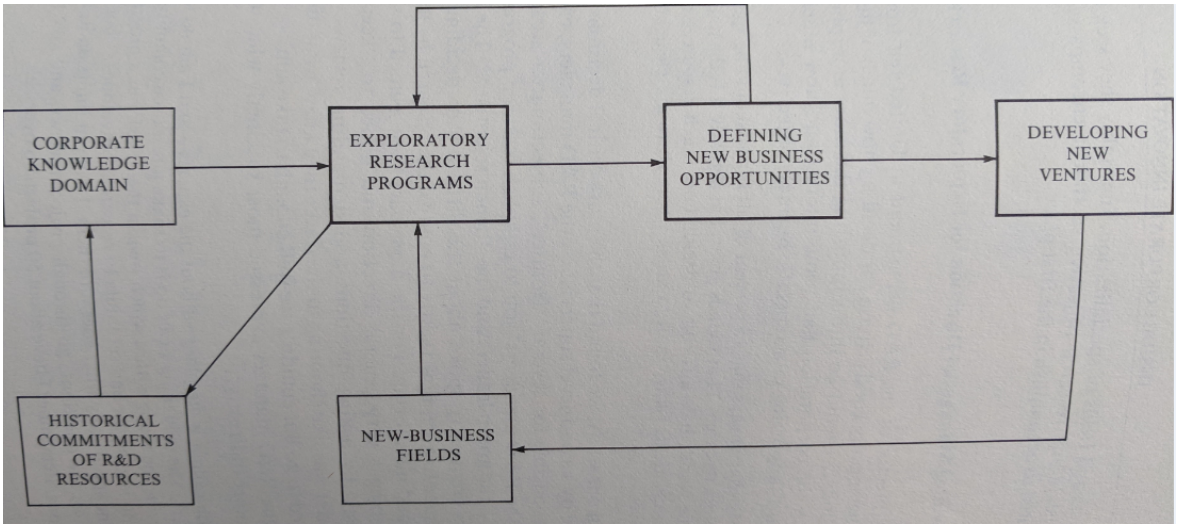
Coradi et al.	2015	Multiple, longitudinal case study	Micro level	x	x	x				x	x	
Choi & Phan	2014	Survey based, quantitative, uses own measurement p. 431	Organisation	x	x		x	x		x	x	
Sok & O'Cass	2015	Survey based, quantitative, measure from He & Wong, 2004	Organisation	x		x	x	x		x	x	
Nemanich et al.	2007	Conceptual	Individual		x		x	x	x	x	x	
Saetre & Brun	2012	Grounded-theory development, multiple case studies (4 cases), qualitative	NPD Projects	x	x	x		x		x	x	
Kim & Huh	2015	Survey based, quantitative, secondary, exploration=scope, exploitation=depth; measurement p. 111	Organisation	x		x	x	x	x	x	x	
Clausen et al.	2013	Survey based, self-reported data, quantitative, own measurements p. 230	Organisation	x			x	x		x	x	
O'Cass et al.	2014	Survey based, questionnaire protocol, developed measure for E/E marketing, quantitative	Organisation		x		x	x				
Karhu et al.	2016	Semi-structured interviews, aiming at processes, qualitative	Team/individual	x	x		x		x	x		
Arvanitis & Woerter	2015	Survey based, quantitative, questionnaire	Organisation			x	x	x	x	x	x	
Mcmillan	2015	Survey based, secondary, quantitative	Organisation	x				x		x		
Atuahene-Gima	2005	Survey based, measurement developed, quantitative	Organisation	x	x			x		x	x	
Yalcinkaya et al.	2007	Survey based, quantitative	Organisation		x			x		x	x	
Smith & Tushman	2005	Conceptual	Individual/team		x			x		x	x	
Lee & Ryu	2002	Simulation modelling	Industry		x	x	x	x		x	x	
Benner & Tushman	2002	Survey based, longitudinal, secondary, quantitative	Organisation		x			x	x	x	x	
Lin et al.	2013	Survey based, quantitative	Business-unit		x	x		x	x	x	x	
Andriopoulos & Lewis	2010	Comparative case studies, qualitative	Organisation		x		x	x		x		
Fauchart & Keilbach	2009	Simulation modelling	Organisation		x			x	x	x		
Carlisel & McMillan	2006	Conceptual	Organisation		x		x	x	x	x		
O'Reilly & Tushman	2011	Multiple case studies, qualitative	Individual		x		x			x		
Wang & Rafiq	2014	Survey based, quantitative	Business-unit		x			x		x	x	
Wang & Jiang	2009	Qualitative case study (single)	Individual/team		x		x	x		x		

Schamberger et al.	2013	Survey based, measurement based on Jansen et al, 2006, quantitative	Organisation		x		x	x		x	x	
Hotho & Champion	2010	Single case study, qualitative	Organisation		x		x	x	x	x		
Liu & Leitner	2012	Single case study, quantitative, measurement from Jansen et al., 2006; Jansen et al., 2009; Gibson and Birkinshaw, 2004	Project/team		x	x		x	x	x		
Cantarello et al.	2012	Single case study, qualitative	Organisation		x			x		x		
Martini et al.	2015	Survey based, quantitative, measurement p.14-16	Organisation		x			x		x		
Yang et al.	2015	Survey based, quantitative, measurement following He and Wong, 2004	Organisation		x	x		x	x	x	x	
Chang et al.	2011	Survey based, measurement from He & Wong, 2004, quantitative	Organisation		x	x		x		x	x	
Lin & McDonough III	2011	Survey based, quantitative; measurement He and Wong, 2004, Cao et al., 2009	Business-unit		x			x		x	x	
Lisboa et al.	2011	Survey based, quantitative; measurement, Atuahene-Gima, 2005	Organisation					x		x		
Jansen et al.	2008	Survey based, questionnaire, quantitative	Senior management team	x	x		x	x		x	x	
Brion et al.	2010	Survey based, questionnaire, quantitative; measurement He and Wong, 2004	Organisation		x		x	x		x	x	
Li et al.	2014	Survey based, quantitative, measurement Jansen et al. 2008	Organisation		x	x	x	x		x	x	
Benner & Tushman	2015	Conceptual	Organisation				x	x		x		
Chandrasekaran et al.	2015	Mixed method, but mainly reported the survey based quantitative results, measurements from He and Wong, 2004	R&D Projects				x	x			x	
Durisin and Todorova	2012	single case study			x		x			x		
Kodam and Shibata	2014	Case study	Projects		x		x	x		x		
Suzuki & Methe	2011	Survey based, secondary, quantitative, different ways of measuring ambidexterity p.55	Organisation		x	x	x	x		x	x	
Voss et al.	2008	Survey based, quantitative, measurement from focus group p. 164	Organisation	x		x	x	x		x	x	x
Zacher et al.	2016	Survey based, quantitative, measurement from Mom et al., 2007	Individual	x	x		x			x		

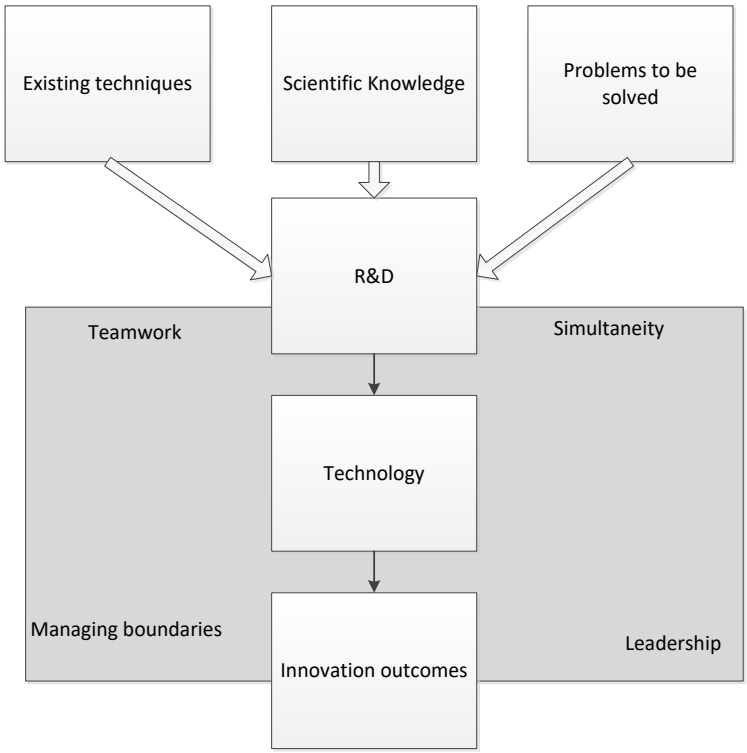
Zhou & Wu	2010	Survey based, quantitative	Organisation				x	x		x	x	x
Wang et al.	2015	Secondary, quantitative	Regions	x		x		x		x		
Jansen et al.	2006	Survey based, their measurements has been applied by many other, quantitative	Organisation		x			x		x	x	

Appendix III: Visualisation of Model Evaluated

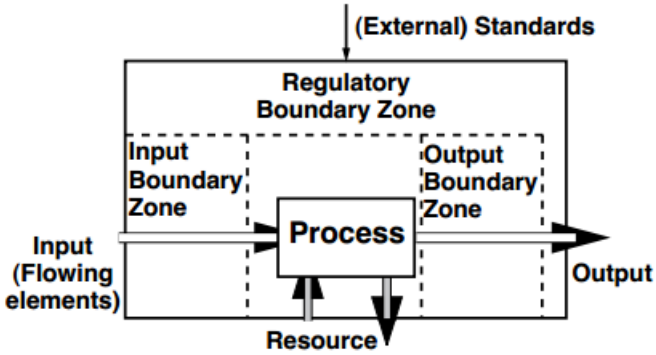
Burgelman and Sayles (1986)



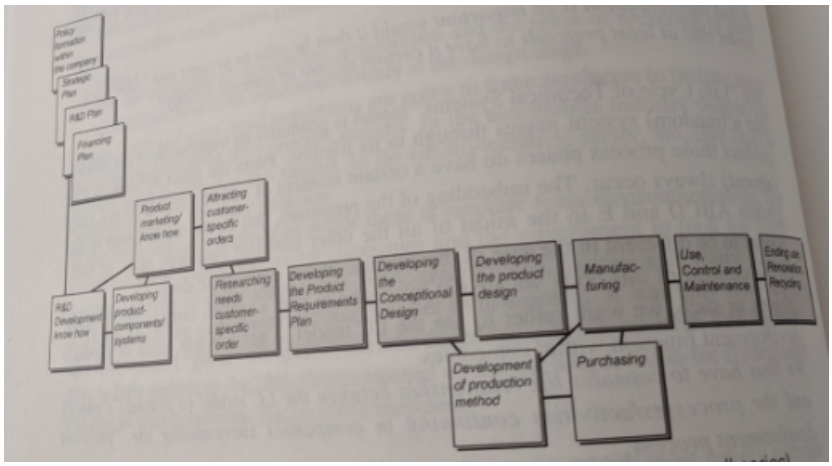
Dussauge et al. (1992)



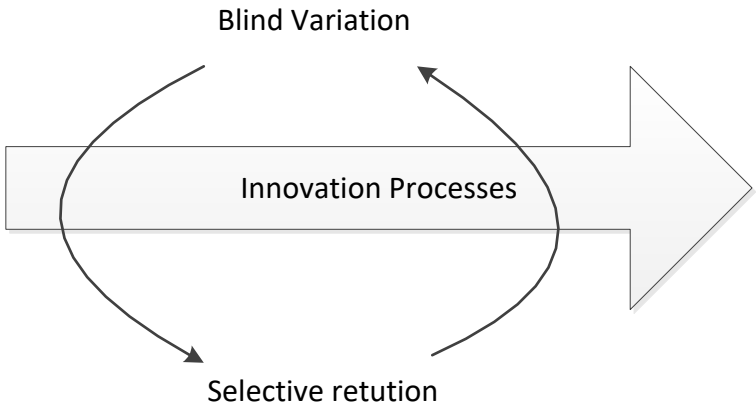
Dekkers (2017) Steady state model



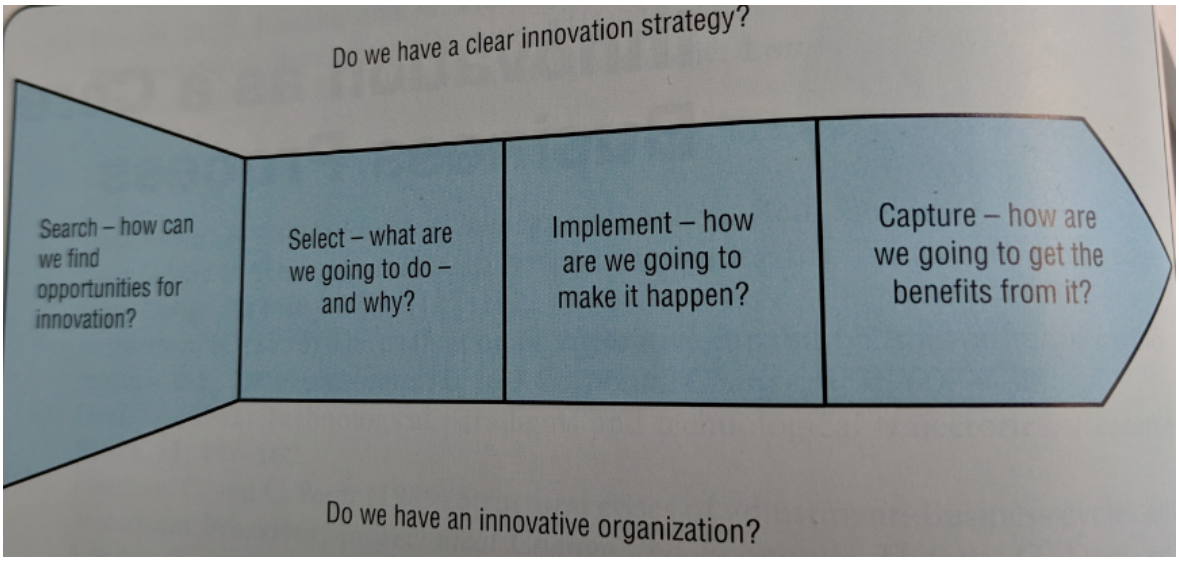
ten Haaf et al. (2002)



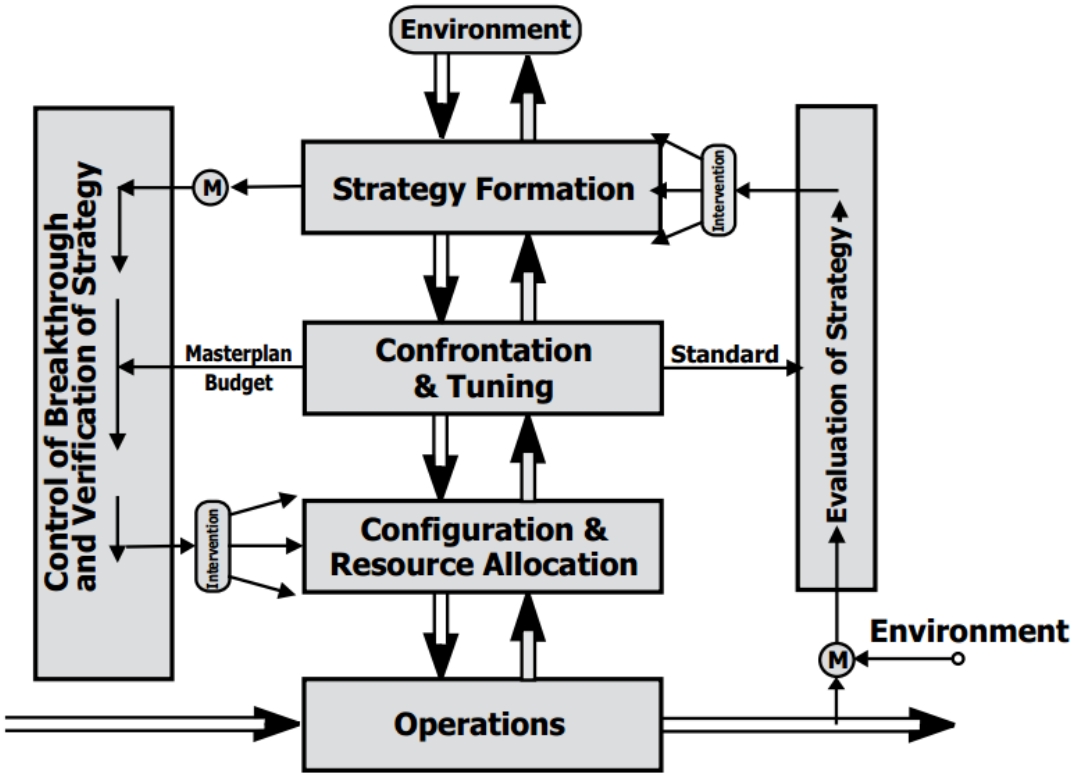
Nickles (2003)



Tidd and Bessant (2013)



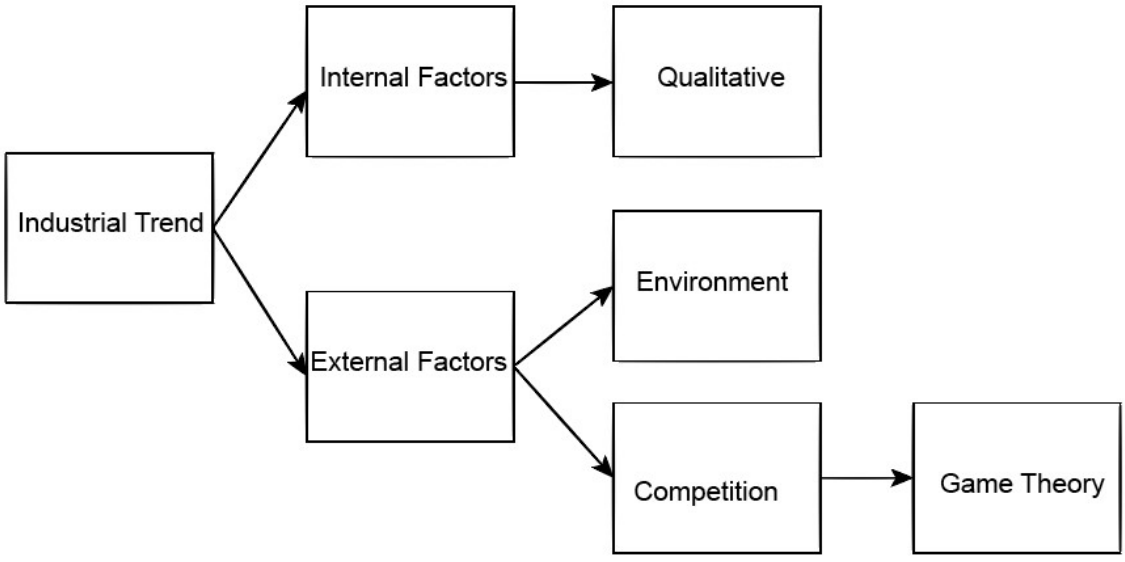
Dekkers (2017) Breakthrough Model



Appendix IV: Attempts in Research Design

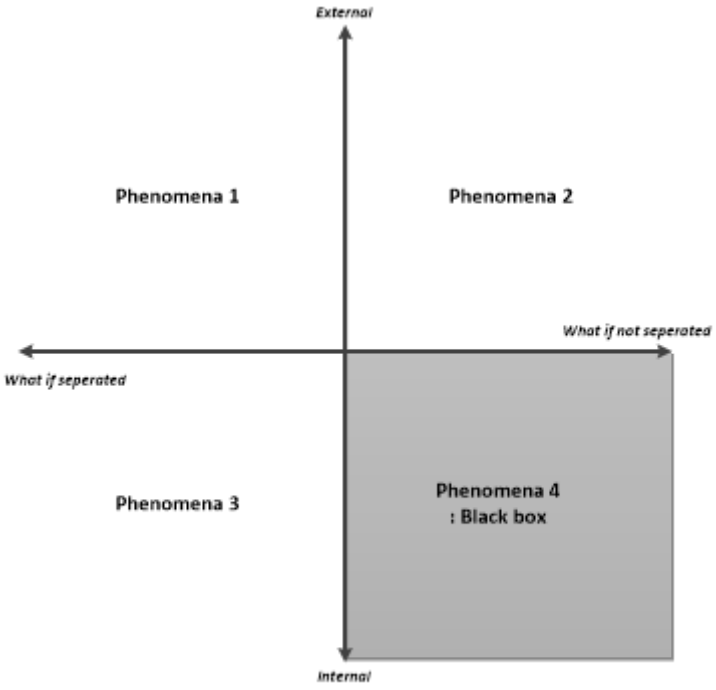
Based on the outcomes from the literature review, it is clear that for a comprehensive examination on the dichotomy between exploration and exploitation, a research design that includes both internal and external level of analysis is needed. Throughout the design processes, this study has developed different version of research design. These attempts will be presented briefly here together with the problems faced in each attempt and thus why it is not taking forward.

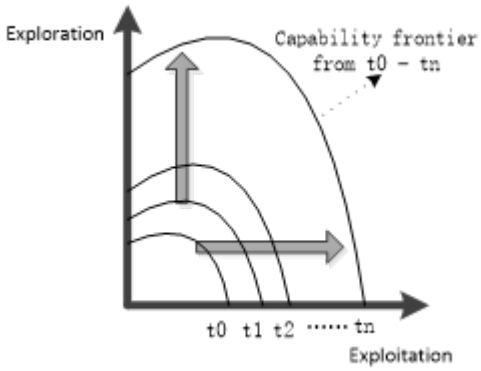
Attempt 1: Treating exploration and exploitation as decisions. The following material reflects the thinking in this design. This attempt of the design starts with mapping out industrial trend using quantitative method, and then explain this trend. The target of this attempt is to falsify exploration and exploitation as decisions, assuming organisations will not make decisions based on them. This attempt is in its early stage when it is discarded. The reason is that it didn't consider what exploration and exploitation should be defined in the industrial level. Also, to examine the assumptions underlying exploration and exploitation, this attempt makes more assumptions, which is not very helpful.

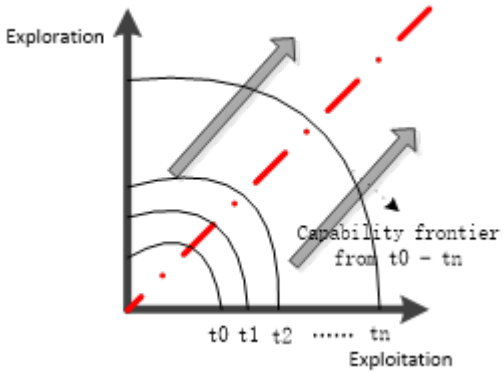


Attempt 2: Using DEA to draw the changes of the capability frontier for multiple years at industrial level of analysis and conduct multiple case studies to understand the internal processes behind these changes. In this attempt, exploration and exploitation are defined as capability in industrial level of analysis and will be treated as internal processes in internal

level of analysis. The following material reflects the thinking in this design. The problem faced with this attempt is that innovation (or R&D) outcomes are not something that is consistent over time. Hence, the changes of capability frontier are hard to be captured based on secondary data.







Attempt 3: DEA for a selected year and multiple case studies based on the results. The overall logic of this attempt is similar to what has been conducted in the final design of this study. In this attempt, based on the results from DEA in the external level, contact was made to all the companies included in the sample. This allows possible comparison between organisations on and not on the frontier, and to further understand whether it is exploration and exploitation that are making the difference. However, the problem regarding this attempt has been the access to companies. Only a limited number of companies has replied to the request of conducting a case study, and it has not been positive. Because of the aim in the case study is on innovation, some companies are being protective to it. There is case where a company has rejected the access of the researcher because of its nationality.

Attempt 4: DEA for a selected year, single case study, focus group with the case company participating. This attempt can be regarded as an ideal situation in the final design presented in the thesis. First, due to the commitment of the contact person in the organisation that has agreed to participate in the study, no further contact was made for additional interviews. Hence, the data and evidence are considered by this study as thin to be reported as a case study. Furthermore, due to availability reasons, the case company did not participate in the focus group discussions arranged.

Appendix V: Full DEA Results

DMU	Score (Input)	Benchmark (Lambda)	Projection (R&D_E)	Score (output)	Benchmark (Lambda)	Projection (N)	Projection (Y)
			Sector B				
B1	0.000986	B57(0.400000); B63(0.600000)	83.6	0.087719	B5(1.000000)	24	57
B2	1	B2(1.000000)	36306	1	B2(1.000000)	33	42
B3	0.001288	B63(1.000000)	16	0.092922	B19(0.714923); B2(0.285077)	32.285077	14.118011
B4	0.002308	B62(0.250000); B63(0.750000)	26.25	0.124017	B19(0.746229); B2(0.253771)	32.253771	12.897073
B5	1	B5(1.000000)	10521	1	B5(1.000000)	24	57
B6	0.383311	B19(0.365672); B5(0.194030); B57(0.440299)	3181.097015	0.652734	B19(0.551849); B2(0.077058); B5(0.371093)	29.108317	26.044284
B7	0.002474	B63(1.000000)	16	0.095239	B19(0.836079); B2(0.090121); B5(0.073800)	31.499724	10.499908
B8	0.244858	B19(0.274627); B5(0.047761); B57(0.677612)	1422.623881	0.481332	B19(0.631233); B2(0.004011); B5(0.364756)	29.08596	22.853255
B9	0.010556	B62(1.000000)	57	0.218238	B19(0.924997); B2(0.075003)	32.075003	5.925117
B10	0.1205	B19(0.166667); B57(0.166667); B62(0.666667)	551.166667	0.350393	B19(0.888099); B2(0.032055); B5(0.079846)	31.393289	8.561806
B11	0.010974	B62(0.750000); B63(0.250000)	46.75	0.188036	B19(0.946732); B2(0.037220); B5(0.016047)	31.908843	5.318141
B12	0.526918	B5(0.195652); B57(0.804348)	2207.26087	0.693971	B5(0.387384); B57(0.612616)	12.97291	28.819659
B13	0.00402	B63(1.000000)	16	0.072533	B19(0.703154); B5(0.182871); B57(0.113975)	27.573682	13.786841
B14	0.018334	B57(0.300000); B63(0.700000)	66.7	0.181146	B19(0.213691); B5(0.278068); B57(0.508241)	16.561196	22.081595
B15	0.007574	B62(0.250000); B63(0.750000)	26.25	0.13017	B19(0.893471); B5(0.083261); B57(0.023268)	30.728953	7.682238
B16	0.010291	B57(0.100000); B63(0.900000)	32.9	0.13791	B19(0.493740); B5(0.162002); B57(0.344257)	21.75329	14.502193
B17	0.024668	B57(0.300000); B62(0.275000); B63(0.425000)	77.975	0.250466	B19(0.412556); B5(0.179797); B57(0.407647)	19.9628	15.97024
B18	0.013292	B57(0.100000); B62(0.175000); B63(0.725000)	40.075	0.170226	B19(0.590622); B5(0.119002); B57(0.290376)	23.498218	11.749109
B19	1	B19(1.000000)	2894	1	B19(1.000000)	32	3
B20	0.0057	B63(1.000000)	16	0.088418	B19(0.566367); B5(0.105235); B57(0.328398)	22.619776	11.309888
B21	0.204819	B19(0.166667); B57(0.166667); B62(0.666667)	551.166667	0.418745	B19(0.747326); B5(0.046584); B57(0.206090)	26.268985	7.164269
B22	0.014914	B57(0.100000); B62(0.175000); B63(0.725000)	40.075	0.180889	B19(0.552373); B5(0.097293); B57(0.350334)	22.112982	11.056491
B23	0.012467	B57(0.100000); B63(0.900000)	32.9	0.122924	B19(0.281766); B5(0.163573); B57(0.554660)	16.270247	16.270247
B24	0.00607	B63(1.000000)	16	0.121171	B19(0.680848); B5(0.058687); B57(0.260466)	24.758395	8.252798
B25	0.006342	B63(1.000000)	16	0.123871	B19(0.664741); B5(0.051975); B57(0.283284)	24.218817	8.072939

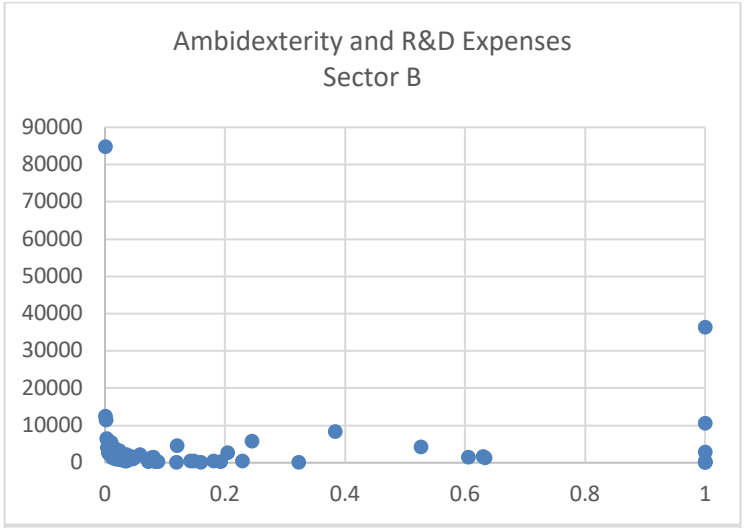
DMU	Score (Input)	Benchmark (Lambda)	Projection (R&D_E)	Score (output)	Benchmark (Lambda)	Projection (N)	Projection (Y)
B26	0.026437	B57(0.300000); B63(0.700000)	66.7	0.186871	B5(0.226200); B57(0.773800)	10.071594	21.405186
B27	0.058259	B19(0.011905); B57(0.297619); B62(0.690476)	128.869048	0.365379	B19(0.452404); B5(0.077538); B57(0.470058)	19.158194	10.947539
B28	0.035462	B57(0.200000); B62(0.600000); B63(0.200000)	74.4	0.305725	B19(0.483688); B5(0.058310); B57(0.458002)	19.625471	9.812735
B29	0.015833	B57(0.100000); B63(0.900000)	32.9	0.171263	B19(0.386251); B5(0.081912); B57(0.531837)	17.516945	11.677963
B30	0.036309	B57(0.300000); B63(0.700000)	66.7	0.217958	B5(0.159830); B57(0.840170)	8.876935	18.352167
B31	0.019855	B57(0.100000); B63(0.900000)	32.9	0.188405	B19(0.345810); B5(0.051780); B57(0.602410)	15.92311	10.615407
B32	0.032906	B57(0.200000); B62(0.100000); B63(0.700000)	53.9	0.265416	B19(0.307311); B5(0.060032); B57(0.632657)	15.070668	11.303001
B33	0.043032	B57(0.300000); B63(0.700000)	66.7	0.23568	B19(0.005120); B5(0.130721); B57(0.864159)	8.486097	16.972193
B34	0.629791	B19(0.320000); B62(0.680000)	964.84	0.750079	B19(0.519915); B62(0.480085)	19.997885	2.039831
B35	0.080301	B57(0.600000); B63(0.400000)	117.4	0.419583	B5(0.123549); B57(0.876451)	8.223878	16.683243
B36	0.606134	B19(0.257937); B57(0.448413); B62(0.293651)	846.162698	0.759472	B19(0.423273); B5(0.006226); B57(0.570501)	17.117159	7.900227
B37	0.024015	B57(0.100000); B63(0.900000)	32.9	0.162728	B19(0.198607); B5(0.062594); B57(0.738799)	12.290477	12.290477
B38	0.077895	B57(0.500000); B62(0.125000); B63(0.375000)	105.625	0.450316	B19(0.143971); B5(0.075560); B57(0.780470)	11.10331	13.323973
B39	0.037871	B57(0.200000); B63(0.800000)	49.8	0.18716	B5(0.109327); B57(0.890673)	7.967879	16.029025
B40	0.012569	B63(1.000000)	16	0.123906	B19(0.387483); B5(0.003706); B57(0.608811)	16.141266	8.070633
B41	0.633628	B19(0.246032); B57(0.150794); B62(0.603175)	774.293651	0.772726	B19(0.401261); B57(0.207983); B62(0.390755)	16.823547	3.882357
B42	0.043646	B57(0.200000); B63(0.800000)	49.8	0.196661	B5(0.092492); B57(0.907508)	7.664861	15.254644
B43	0.047977	B57(0.200000); B63(0.800000)	49.8	0.266684	B19(0.176851); B5(0.036176); B57(0.786974)	11.249277	11.249277
B44	0.01768	B63(1.000000)	16	0.092318	B19(0.168135); B5(0.025592); B57(0.806273)	10.832169	10.832169
B45	0.045748	B57(0.100000); B62(0.175000); B63(0.725000)	40.075	0.304308	B19(0.265944); B57(0.504039); B62(0.230017)	13.14456	6.57228
B46	0.023845	B63(1.000000)	16	0.099026	B19(0.152801); B5(0.006972); B57(0.840227)	10.098311	10.098311
B47	0.030418	B63(1.000000)	16	0.106382	B19(0.128576); B57(0.814295); B62(0.057129)	9.400105	9.400105
B48	0.03397	B63(1.000000)	16	0.111182	B19(0.110861); B57(0.777254); B62(0.111885)	8.994261	8.994261
B49	0.036117	B63(1.000000)	16	0.207476	B19(0.119907); B57(0.358002); B62(0.522091)	9.639669	4.819835
B50	0.228929	B57(0.500000); B63(0.500000)	100.5	0.494624	B5(0.024574); B57(0.975426)	6.442337	12.130418
B51	0.18125	B57(0.300000); B63(0.700000)	66.7	0.338569	B5(0.017705); B57(0.982295)	6.318692	11.814435
B52	0.148214	B57(0.200000); B63(0.800000)	49.8	0.277952	B19(0.043817); B5(0.003125); B57(0.953058)	7.195482	10.793222

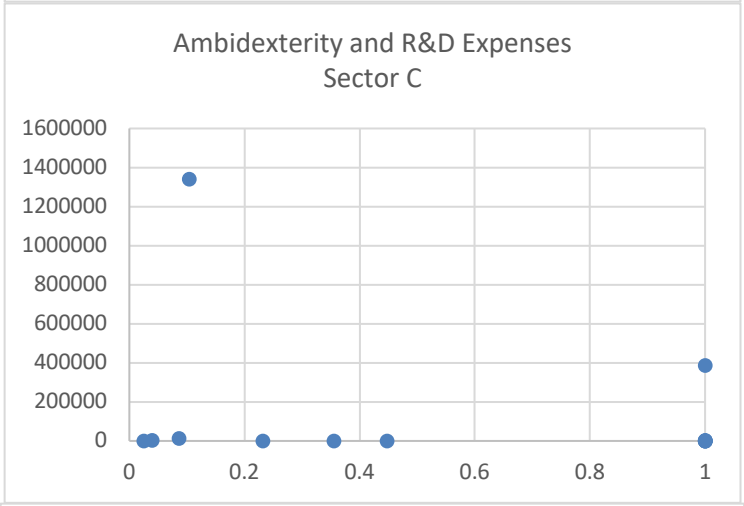
DMU	Score (Input)	Benchmark (Lambda)	Projection (R&D_E)	Score (output)	Benchmark (Lambda)	Projection (N)	Projection (Y)
B53	0.142966	B62(0.750000); B63(0.250000)	46.75	0.645024	B19(0.093532); B57(0.036326); B62(0.870142)	9.301973	1.550329
B54	0.088682	B62(0.250000); B63(0.750000)	26.25	0.450436	B19(0.079456); B57(0.106116); B62(0.814428)	8.880288	2.220072
B55	0.072072	B63(1.000000)	16	0.139725	B19(0.030658); B57(0.609558); B62(0.359784)	7.156891	7.156891
B56	0.08377	B63(1.000000)	16	0.144339	B19(0.020673); B57(0.588680); B62(0.390647)	6.928143	6.928143
B57	1	B57(1.000000)	185	1	B57(1.000000)	6	11
B58	0.192398	B57(0.100000); B63(0.900000)	32.9	0.196626	B57(0.917160); B63(0.082840)	5.751479	10.171598
B59	0.119403	B63(1.000000)	16	0.280171	B19(0.015691); B57(0.253786); B62(0.730523)	7.138489	3.569244
B60	0.323009	B62(0.500000); B63(0.500000)	36.5	0.675773	B19(0.017734); B57(0.044432); B62(0.937834)	7.39893	1.479786
B61	0.16	B63(1.000000)	16	0.187245	B57(0.434060); B62(0.259605); B63(0.306334)	5.340602	5.340602
B62	1	B62(1.000000)	57	1	B62(1.000000)	7	1
B63	1	B63(1.000000)	16	1	B63(1.000000)	3	1
			Sector C				
C1	0.104113	C2(0.357676); C5(0.030384); C8(0.611940)	139823.7058	0.978967	C2(0.378440); C8(0.621560)	50.05277	19.408217
C2	1	C2(1.000000)	387000	1	C2(1.000000)	37	48
C3	0.086202	C11(0.684274); C5(0.295318); C8(0.020408)	1132.260504	0.479825	C2(0.026706); C5(0.746903); C8(0.226391)	20.840928	16.672742
C4	0.039885	C11(0.666667); C13(0.333333)	189.333333	0.1517	C2(0.006179); C5(0.239318); C8(0.754503)	46.143664	6.591952
C5	1	C5(1.000000)	3100	1	C5(1.000000)	9	20
C6	0.356036	C11(0.709484); C5(0.127251); C8(0.163265)	923.201681	0.482471	C2(0.000020); C5(0.464578); C8(0.535402)	35.235254	10.36331
C7	0.025224	C13(1.000000)	62	0.081465	C11(0.118378); C5(0.564267); C8(0.317355)	24.55038	12.27519
C8	1	C8(1.000000)	2139	1	C8(1.000000)	58	2
C9	0.447788	C11(1.000000)	253	0.616901	C11(0.890411); C5(0.109589)	9	4.863014
C10	0.23221	C13(1.000000)	62	0.324297	C11(0.995083); C5(0.004917)	9	3.083597
C11	1	C11(1.000000)	253	1	C11(1.000000)	9	3
C12	1	C12(1.000000)	89	1	C12(1.000000)	1	2
C13	1	C13(1.000000)	62	1	C13(1.000000)	3	1
			Sector D				
D1	1	D1(1.000000)	65718	1	D1(1.000000)	27	20
D2	1	D2(1.000000)	14000	1	D2(1.000000)	38	17
D3	0.076595	D10(0.204545); D32(0.272727); D36(0.522727)	846.681818	0.35	D1(0.021978); D10(0.978022)	14.285714	20
D4	0.387417	D10(0.783784); D32(0.054054); D34(0.162162)	3016.432432	0.800836	D1(0.062868); D10(0.930171); D2(0.006960)	14.984339	19.979119
D5	0.626762	D10(0.466667); D2(0.133333); D25(0.400000)	4136	0.75889	D10(0.513128); D2(0.316446); D25(0.170426)	21.083422	15.812567
D6	0.539501	D10(0.636364); D32(0.181818); D36(0.181818)	2471.454545	0.700555	D1(0.011363); D10(0.983359); D2(0.005279)	14.274403	19.984164
D7	0.006569	D36(1.000000)	30	0.1	D10(1.000000)	14	20
D8	0.972362	D2(0.222222); D25(0.777778)	4053.777778	0.985892	D2(0.231232); D25(0.768768)	17.243275	4.699718

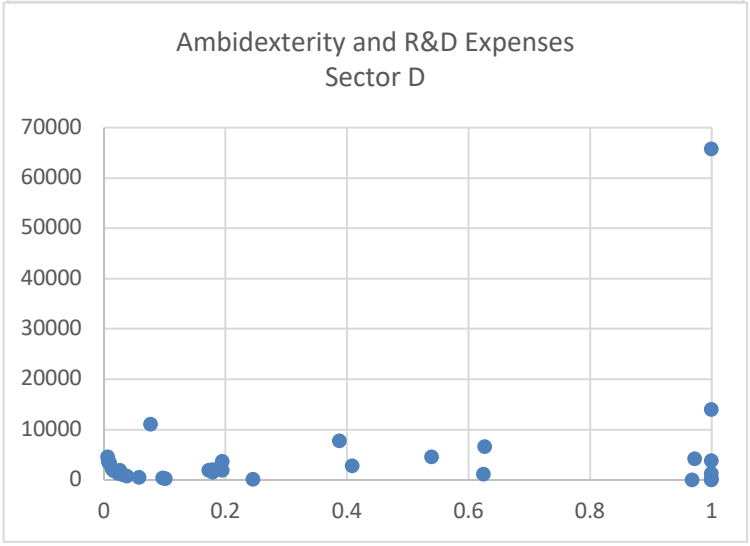
DMU	Score (Input)	Benchmark (Lambda)	Projection (R&D_E)	Score (output)	Benchmark (Lambda)	Projection (N)	Projection (Y)
D9	0.007641	D36(1.000000)	30	0.15	D10(1.000000)	14	20
D10	1	D10(1.000000)	3824	1	D10(1.000000)	14	20
D11	0.007853	D36(1.000000)	30	0.125662	D10(0.234861); D2(0.155970); D25(0.609169)	15.915769	7.957885
D12	0.195318	D10(0.159091); D32(0.545455); D36(0.295455)	714.863636	0.35433	D10(0.818114); D2(0.024326); D25(0.157560)	14.111156	16.933387
D13	0.008636	D36(1.000000)	30	0.141548	D10(0.654676); D2(0.043164); D25(0.302160)	14.129468	14.129468
D14	0.009055	D36(1.000000)	30	0.112076	D10(0.865314); D36(0.134686)	12.383764	17.845018
D15	0.009099	D36(1.000000)	30	0.072586	D10(0.646332); D2(0.031028); D25(0.322641)	13.776742	13.776742
D16	0.408483	D10(0.157895); D25(0.429825); D34(0.412281)	1149.061404	0.648668	D10(0.201079); D2(0.084124); D25(0.714797)	13.874594	6.166486
D17	0.013717	D36(1.000000)	30	0.161022	D10(0.253652); D2(0.024434); D25(0.721914)	12.420671	6.210336
D18	0.17897	D10(0.052632); D25(0.087719); D34(0.859649)	358.298246	0.486662	D10(0.134834); D2(0.034236); D25(0.830930)	12.328882	4.109627
D19	0.026185	D34(0.666667); D36(0.333333)	49.333333	0.339785	D10(0.257139); D2(0.000028); D25(0.742833)	11.772162	5.886081
D20	0.172894	D10(0.054054); D32(0.486486); D34(0.459459)	320.891892	0.447555	D10(0.300163); D25(0.578393); D34(0.121444)	11.171823	6.703094
D21	0.194833	D10(0.052632); D25(0.087719); D34(0.859649)	358.298246	0.501203	D10(0.140219); D2(0.020390); D25(0.839391)	11.971189	3.990396
D22	0.016565	D36(1.000000)	30	0.174281	D10(0.249362); D25(0.705249); D34(0.045389)	11.475753	5.737876
D23	0.179519	D10(0.062500); D36(0.937500)	267.125	0.492676	D10(0.384291); D36(0.615709)	6.611492	10.148656
D24	0.02449	D36(1.000000)	30	0.135983	D10(0.298960); D32(0.336800); D34(0.364240)	7.353839	7.353839
D25	1	D25(1.000000)	1212	1	D25(1.000000)	11	1
D26	0.624585	D10(0.052632); D25(0.421053); D34(0.526316)	742.631579	0.796917	D10(0.079456); D25(0.720596); D34(0.199948)	10.038682	2.50967
D27	0.031746	D36(1.000000)	30	0.254494	D10(0.241170); D36(0.758830)	4.894043	7.858724
D28	0.0375	D36(1.000000)	30	0.275967	D10(0.202952); D36(0.797048)	4.435424	7.247232
D29	0.058027	D36(1.000000)	30	0.330373	D10(0.128361); D36(0.871639)	3.540327	6.053769
D30	0.097403	D36(1.000000)	30	0.386669	D10(0.073274); D36(0.926726)	2.879283	5.172377
D31	0.10101	D36(1.000000)	30	0.780337	D10(0.070374); D36(0.929626)	2.844491	5.125988
D32	1	D32(1.000000)	179	1	D32(1.000000)	4	3
D33	0.245902	D36(1.000000)	30	0.683686	D10(0.024249); D36(0.975751)	2.290986	4.387981
D34	1	D34(1.000000)	59	1	D34(1.000000)	5	1
D35	0.967742	D36(1.000000)	30	0.95082	D34(0.034483); D36(0.965517)	2.103448	3.896552
D36	1	D36(1.000000)	30	1	D36(1.000000)	2	4

Appendix VI: Distribution Chart of DEA Results

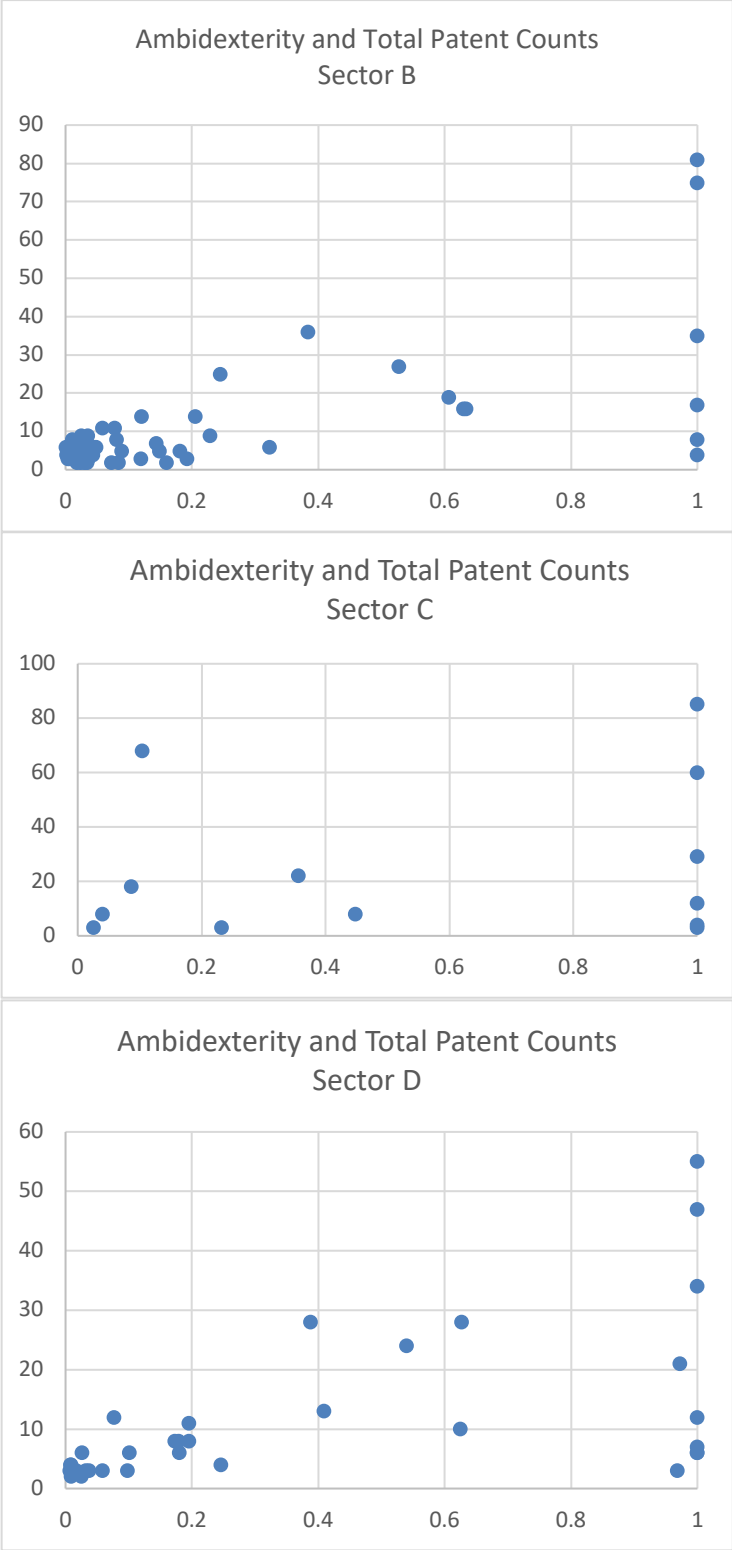
Ambidexterity and R&D Expenditures



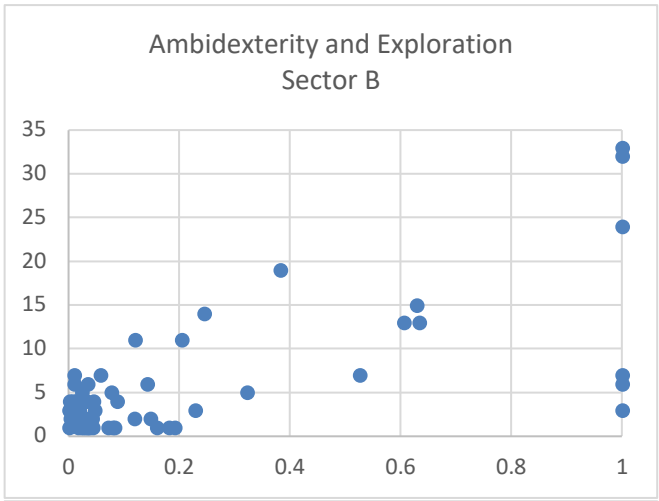


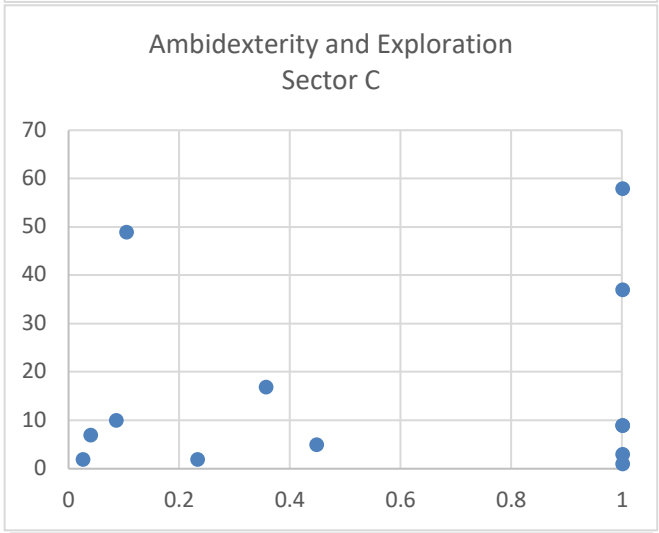


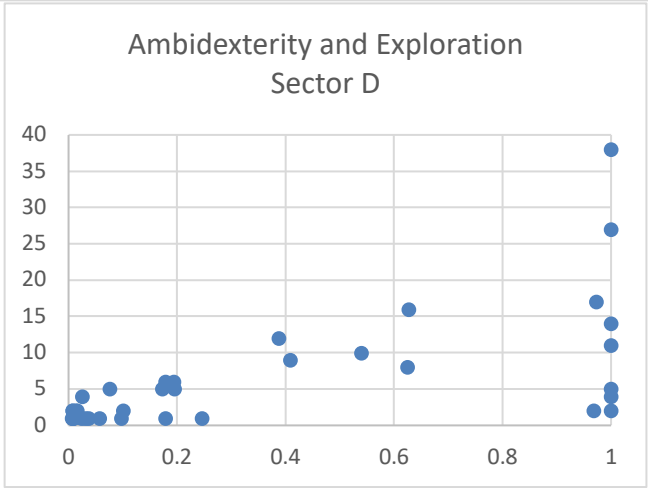
Ambidexterity and Total Patent Counts



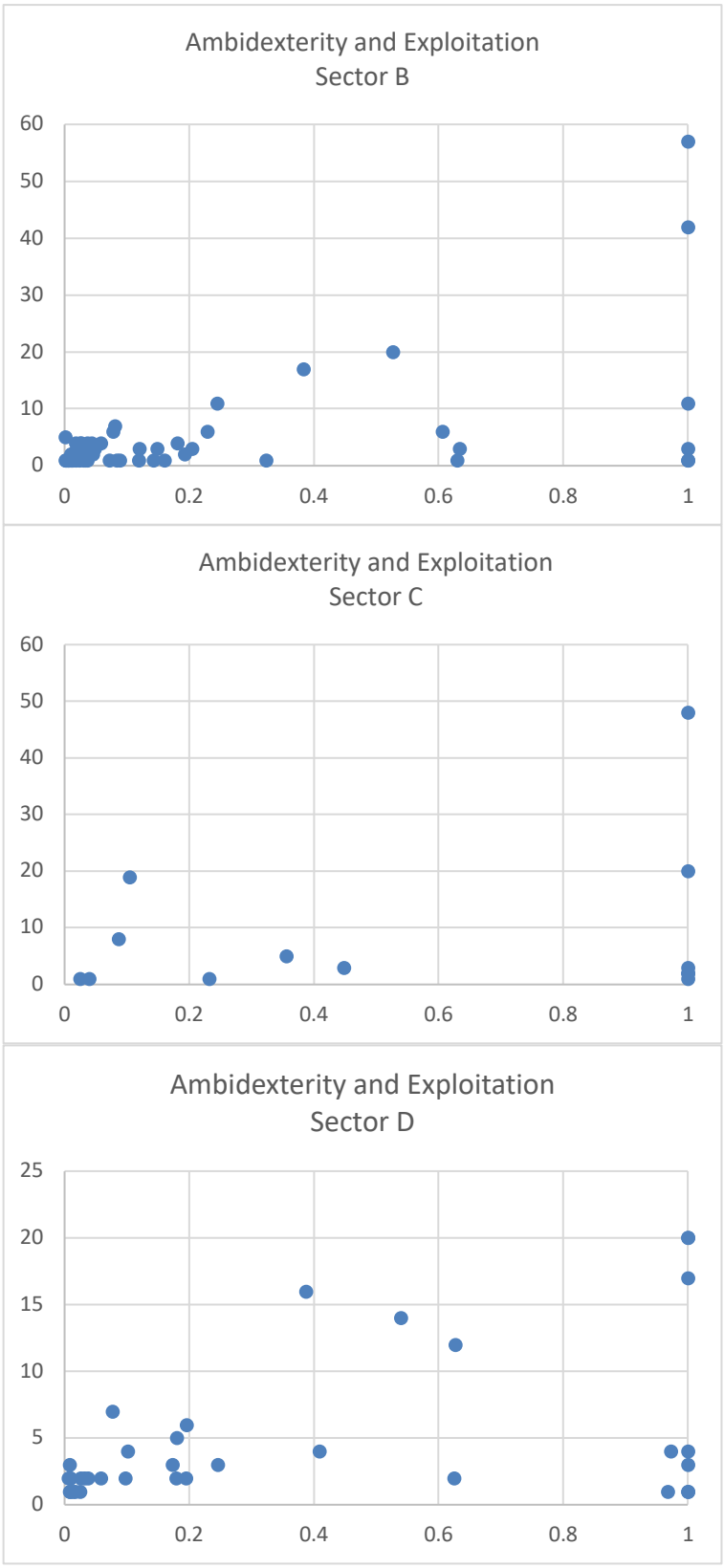
Ambidexterity and Exploration







Ambidexterity and Exploitation



Appendix VII: Supplement Material for Qualitative Study

Appendix IV presents supplement materials for the primary data collection. This includes ethical approval for both focus groups and interviews, notes for moderators in the focus groups, and the paper containing keys words regarding exploration and exploitation that is handed to participants.

Ethical approval for interviews

University of Glasgow
College of Social Sciences

Application Approved

Ethics Committee for Non-Clinical Research Involving Human Subjects

Staff Research Ethics Application ☐ Postgraduate Student Research Ethics Application ☐x

Application Details

Application Number: 400160133

Applicant's Name: Qijun Zhou

Project Title: *A Critical Study of Exploration and Exploitation in the Context of Innovation Management*

Application Status:	**Approved**
Start Date of Approval:	05/06/2017
End Date of Approval of Research Project:	14/01/2019

Please retain this notification for future reference. If you have any enquiries please email socsci-ethics@glasgow.ac.uk.

University of Glasgow
College of Social Sciences
Florentine House, 53 Hillhead Street. Glasgow G12 8QF
The University of Glasgow, charity number SC004401

Approval for focus groups

09/02/2019

Dear Qijun Zhou

College of Social Sciences Research Ethics Committee

Project Title: **A Critical Study of Exploration and Exploitation in the Context of Innovation Management**
Application No: 400180075

The College Research Ethics Committee has reviewed your application and has agreed that there is no objection on ethical grounds to the proposed study. It is happy therefore to approve the project, subject to the following conditions:

- Start date of ethical approval: ____13/02/19_____
- Project end date: _____24/04/19____
- Any outstanding permissions needed from third parties in order to recruit research participants or to access facilities or venues for research purposes must be obtained in writing and submitted to the CoSS Research Ethics Administrator before research commences. Permissions you must provide are shown in the *College Ethics Review Feedback* document that has been sent to you.
- The data should be held securely for a period of ten years after the completion of the research project, or for longer if specified by the research funder or sponsor, in accordance with the University's Code of Good Practice in Research: (https://www.gla.ac.uk/media/media_490311_en.pdf) (Unless there is an agreed exemption to this, noted here).
- The research should be carried out only on the sites, and/or with the groups and using the methods defined in the application.
- Any proposed changes in the protocol should be submitted for reassessment as an amendment to the original application. The *Request for Amendments to an Approved Application* form should be used:
  https://www.gla.ac.uk/colleges/socialsciences/students/ethics/forms/staffandpostgraduateresearchstudents/

Yours sincerely,

Dr Muir Houston
College Ethics Officer

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Notes for Moderators

Introduction

The purpose of this focus group is to generate open discussion about: 1) innovation process and system, 2) innovation activities, 3) decision making and information flow in innovation. But most importantly, to make sense of exploration and exploitation. Hence, you will first need to know how exploration and exploitation are defined. Here it is:

- **Exploration**: search, variation, risk taking, experimentation, play, flexibility, discovery, innovation (basically this means **searching for new knowledge**)
- **Exploitation**: refinement, choice production, efficiency, selection, implementation, execution (basically this means **searching for improving current knowledge**)

Before the discussion starts, you may want to mention your role and how this discussion may unfold. Here is an example but feel free to use your own words:
"Good afternoon and welcome to our session today. Thank you for taking time to join this group discussion. My name is XXX, I will be the moderator of our group. Before we begin, let me suggest something that will make our discussion more productive. Please speak up and talk with others during the discussion. There are no wrong answers, only different points of view. We're recording the session because we don't want to miss any of your comments. And in our later reports there will not be any names attached to comments. My role here is to ask questions and listen. I won't be participating in the conversation. This first session is on innovation activities …"
At the beginning of the first group discussion, ask the participants to introduce themselves, this may include their name and job title. After each round of discussion, please ask the participants to write down any additional things or thoughts that they may want to raise on the post-it note and stick it on the Research model that I will print out and hang on the wall.

Theme one: innovation activities

The first round of discussion is about innovation activities, what they are, what should they be like, and whether exploration and exploitation can describe innovation activities. At the beginning of this session, participants will be given a piece of paper with all the keywords mentioned above on how exploration and exploitation is defined (without being associated with exploration and exploitation). At the beginning of the discussion, ask the participants to circle out words that they feel fits what innovation activities are like in their organisations. Allow 3-5 minutes for this.
You may want to start the discussion based on this paper. Here are some questions you may want to include:

- **(Start with one person and go through the whole group) Could you share with the group what you have circled out and why?**
- Can you give us some examples of innovation activities in your organisation that met these words?
- Can you give us some examples of innovation activities in your organisation that are different than these words? (If any) what do you think is missing?
- **Can successful innovation activities rely on only one of the concepts/words? [***This is to figure out whether there is activity in organisations that can be 'pure exploration' or*

'pure exploitation', so you may want to change the way of how this question is asked for clarification]

- Besides these words, what do you think successful innovation activities should be?

The two questions highlighted are the ones you must include. If you are running out of time you don't have to include the last question.
For your record, innovation activities mean all the activities that are related to innovation throughout the process. For example, idea generation (brainstorming, analysing marketing demand for new products etc.), R&D (product design, research for tech etc.), manufacturing (organising production line for new products etc.), HR (recruiting for skilled worker in design team, change recruiting criteria for new product development teams etc.) to name but a few. I would rather encourage the participant to speak up what they think count as innovation activities. However, there may be a situation that the discussion is focused too much on the 'early stages' (brainstorming and such). In this case, you may want to divert the discussion a bit so that other stages can be covered.

Theme two: Strategic consideration in Innovation

The second round of the discussion will be focused on strategic orientation in innovation with attention paid to how strategic orientation can influence implementation of innovation and how innovation enables the accomplishment of certain strategic orientation. An important fact to track down here what are the orientations and what factors are influencing setting orientation (any of them linked to exploration and exploitation??). You may want to start this round of discussion linking to my presentation. I will talk about strategic orientation and will use the term competitive priority (this includes quality, lead time and time-to-market, price and cost, and flexibility). Based on this, here are some questions you may want to include:

- **(Starting with one person) Can you tell us what overall target your organisation want to achieve (or what are the strength that your organisation wants to exploit, or what priority in the competition that your organisation wants to focus on)?**
- From your perspective, why do you think your organisation have set such orientation/target?
- **How and what you or your organisation have done towards accomplishing such orientation/target?**
- (If any) what are the outcomes?
- Do you think there is anything else you or your organisation should have done to accomplish the orientation?
- **Has there been a change of orientation happened in your organisation? How does that affect your daily practice related to innovation?**
- (If any) the reason for the change?

The questions highlighted are the ones you must cover in the discussion. If you have additional time, the second question may be interesting although I doubt the participants will have sufficient information to cover it.
Few things to note about this round. Because these are rather focused questions, so before the session, encourage the participant to ask each other for example about why they

decided a certain target, why did they choose to do certain things; or if some of them are sharing similar targets, ask them to join the discussion and supplementing. Another thing is that many of the participants may have limited information on strategic orientations and such because they may be from specific functions (design, engineering, HR etc.). In this case you may want to shift the focus to how organisational strategic orientation reflected in their function. If they are still unclear, try to ask them about the target of their own job and responsibilities.

Theme Three: Decision-making and Information Flow in innovation

The third round will be focusing on how decisions are made and how 'feedback' works in innovation. This is to track down to what extent past experience and outcomes influence future decision-making. The important point is to know that if exploration and exploitation have any impact on future decision-making at all. Here, decision-making may mean decisions on what project to take, how projects are managed, what would be next steps after the current projects to name but a few. Also, this round is about a better understanding of how communication works (across functions, hierarchy, individuals etc.). Based on this, here are some questions you may want to include:

- **How do you decide what innovation activities to do, what are the factors that are affecting your choice? Could you rank these factors?**
- **During the innovation process, how does communication work across different functions and hierarchies or between different people?**
- **Will/how communication affects decision-making and the design, operation, logistics or marketing activities in innovation?**
- What is your take on serendipity in innovation? Do you have any examples to share with the group?

Again, questions highlighted are the ones you must include. For the second question, you don't have to cover all three aspects of function, hierarchies and individuals, just have a feel on what the group is comfortable to talk about. It would be great if you can include the last question and collect some examples, its will be a great addition to my study.

For your record, more details about this round. For decision-making, choosing what to innovation activities do can be for example, if someone did brainstorm for a new product idea, why did they use brainstorming, why did they brainstorm for new products etc. Possible answers could be they are following orders, they know that brainstorming is likely to generate new ideas, the current resource they have only allows brainstorming, customer want something, but no one has any idea etc.

In terms of communication, this is about how information flow in innovation (also known as knowledge sharing I suppose). In plain terms, this means how and how often do, for example, marketing guys involved in product design (cross function), how and how often do they report to higher-level of management, and higher-level giving instructions to them (cross hierarchies). Communication between individual is not important here. The communication may also include information from previous projects, and to what extent do that information impact the current projects.

Regarding the impact, I have included four different aspects. 'Design' may include features of design, new technology used in a design, outlook of design etc. 'Operation' may include, production line, production arrangements for new products, moving people around etc. 'Logistics' may include finding suppliers, arrange for supplies, transportations of goods, storage etc. 'Marketing activities' include anything about money money money…

Keywords for participants

Before we start the discussion, let's try to get some senses of innovation activities. Please circle the words that you think fits your understanding of innovation activities in the organisations.

search

variation

choice

risk taking

selection

experimentation

play

flexibility

discovery

refinement

production

efficiency

implementation

execution

If you think none of the words fit your understanding about innovation activities, feel free to leave the paper blank. Alternatively, you can write down other words that you think can describe innovation activities in the box.

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