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The Impact of China's National System of Innovation On
Bottom-Up Learning for Innovation in Firms:
Case Studies of
China's Automobile and Railway Equipment Sectors

By

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Abstract

Existing National System of Innovation (NSI) literature mainly focuses on the impact of NSI on national-level or sectoral-level innovations. *Whether* and *how* NSI impacts firm-level innovation still lacks comprehensive theoretical exploration. This study aims to address the knowledge gap by developing a theoretical framework to analyse and evaluate how two aspects of institutions in China's NSI might contribute to the development of a firm's innovation through bottom-up learning (BUL). The two aspects of institutions in focus are corporate governance and the firm's access to capital.

This research adopts a multiple case study method. 37 in-depth interviews in seven leading firms in China's automobile and railway equipment sectors were carried out. The case samples included central State-Owned Enterprises (SOEs), local SOEs and private firms. The author performed multiple case analyses to identify and examine the impact of corporate governance along with the firm's access to capital, and how these factors influence the likelihood of the firm's adoption of BUL practices.

This study fills the research gap in three ways. First, by expanding the Corporate Governance and Financial (CG&F) framework by Tylecote and colleagues (Tylecote and Conesa, 1999) this study establishes how NSI shapes a firm's BUL choices for innovation depending on four institutional factors: (1) whether the top manager of a firm is an insider or outsider, (2) the length of employment of the top manager, (3) the firm's access to capital, and (4) the level of competition faced by the firm. Second, based on the analysis of the above four factors, a new finding is that central and local SOEs should be separately considered because the institutional conditions they face for BUL for innovation are

different. Third, to support the analysis between NSI and BUL, the study operationalises the concept of BUL by systematically introducing five underlying practices.

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Chapter 1: INTRODUCTION

1.1 Motivation

A recent change amongst developing countries has been the increasing focus on the innovation and the development of a strong national system of innovation (NSI) that allows catch up. Developing countries like China also decided to use innovation as an engine to drive economic growth and to help catch up with those developed countries by 2020 (Serger and Breidne, 2007). Therefore, a key challenge is what is an effective NSI for China and how might it be developed?

The NSI is a widely regarded approach for analysing innovative actors and interactions amongst them that is shaped by institutions within national boundaries (Freeman, 1987; Lundvall, 1992). The NSI, in a developing country approach, focuses more on studying technological learning, diffusing and improving activities of developing countries who import technologies from developed countries (Freeman, 1987; Freeman, 1988; Lall, 2000; Viotti, 2002; Lundvall *et al.*, 2009).

Although China has proposed its national strategic plan to become an innovative country by 2020 (Serger and Breidne, 2007), how to develop the innovation capability of China's firms, and how China's NSI formulates an appropriate institutional environment to help firms develop their innovation capability, are two critical questions that needed to be addressed.

Developing indigenous innovation in China requires a significant amount of effort. It is argued that China lacks the relevant abilities to develop indigenous innovations (e.g. Gu, 1999; Gu and Lundvall, 2006; Liu and Tylecote, 2009). In addition, China's SOEs are

either highly dependent on imported foreign technologies (i.e. the entire production line, machinery, *etc.*) or predominantly rely on imitating products from the foreign market through reverse engineering (Xiao *et al.*, 2013). Taking the Chinese automobile sector as an example, a growing body of literature (e.g. Lee *et al.*, 1997; Harwit, 2001; Wang, 2003; Liu and Tylecote, 2009) shows that large-scale firms in China's automobile sector, most of which are SOEs, are incapable of developing cars without some reliance on foreign technologies.

The low capability of China in developing indigenous innovations could be explained by their lack of bottom-up innovation (OECD, 2008; Lundvall *et al.*, 2009). Many researchers have suggested that an employee's personal knowledge repository is an important source of knowledge (Gibbons and Johnston, 1974; Pavitt, 1984; Bessant *et al.*, 1994; Bessant and Caffyn, 1997), and formulating a receptive environment that allows employees to actively propose suggestions to both product and process innovation, is a key approach to improving the innovation performance of a firm (March, 1991; Lam, 2002; Mom *et al.*, 2006; Andersen, 2008; Aoki, 2008; Wei *et al.*, 2011).

Following previous work, a "bottom-up learning (BUL)" approach for innovation is proposed in this research as a potential route to proliferate the technological innovation capability in China's firms. This approach emphasises the importance of gathering and using knowledge from the "bottom (shop floor)" level of firms, as an important source of knowledge for developing the innovation capability of firms.

In this research, "Bottom-up learning" is defined as knowledge creation, learning and sharing activities by shop floor employees to produce creative solutions to problems, or to develop processes and enhance product innovation.

1.2 Research Aim and Questions

The research objective is to understand the impact of China's NSI on innovation activities in firms. This research fills two knowledge gaps, namely: 1) how institutions influence firm-level practices and 2) to operationalise the concept of BUL.

This research aims to fill these two knowledge gaps by studying how two aspects of institutions of China's NSI, which are a corporate governance system and a firm's access to capital, influence a firms' adoption of BUL practices. This objective has been further translated into three research questions that will be addressed in this research including:

Research question 1: *“Do China's firms have bottom-up learning (BUL) practices to develop their innovation capability, and how embedded are BUL practices?”*

Research question 2: *“How does the level of firms' BUL embeddedness vary amongst firms with different ownership?”*

Research question 3: *“How does China's corporate governance system, and firms' access to capital, influence the adoption of embedded BUL practices in firms?”*

To address these three research questions, this research formulates a theoretical framework consisting of three institutional factors to analyse and evaluate the impact of China's corporate governance system and firms' access to capital on their adoption of BUL. The three factors include: 1) whether the top manager of a firm is an insider or an outsider, 2) the length of the top manager's employment, and 3) the firm's access to capital.

1.3 Knowledge Gaps

Based on a systematic literature review in the relevant topics, two main research gaps are identified to be addressed in this thesis.

Firstly, the NSI approach provides a useful framework to study how national institutions shape the technological specialisations of countries (Freeman, 1987; Lundvall, 1992). However, how NSI impacts firm-level innovation still lacks comprehensive theoretical exploration. Because national technological innovation capability is an aggregation of all innovation activities of firms in that country (Lundvall *et al.*, 2009), it is very important to understand why and how firms' innovation activities are shaped by institutions at the national level.

Therefore, this research aims to bridge the gap between studies of NSI and management studies that focus more on firm-specific practices. In this light, it is possible to discover how national institutions influence firms' behaviour when engaging innovation.

Second, although the concept of BUL has been widely suggested as an important approach to develop innovation capability (March, 1991; Bessant and Caffyn, 1997; Lam, 2002; Mom *et al.*, 2006; Andersen, 2008; Aoki, 2008; Høyrup, 2010; Wei *et al.*, 2011), the volume of literature that focuses on how BUL is implemented in firms, and how to evaluate the embeddedness of those BUL practices, is considerably limited. This is because the concept of BUL is new and modern, and has not yet been operationalised by academics. Therefore, this research will initiate the effort to operationalise the concept of BUL to make it a useful tool, or approach, for developing firms' innovation capability.

This research aims to fill these two research gaps by studying how China's corporate governance system and firms' access to capital influence firms' adoption of BUL

practices. Corporate governance and firms' access to capital are two important aspects of institutions in China's NSI. The adoption of the BUL practice is a form of innovation activities that are crucial for developing the innovation capability of firms.

To support the analysis between NSI and BUL, this research will operationalise the concept of BUL by identifying BUL practices from literature in knowledge management (KM), organisational learning (OL), human resource management (HRM) and operation management (OM).

Moreover, this research evaluates the level of embeddedness of BUL practices in firms according to criteria developed from the available literature. In this research, an embedded BUL practice means that the practice is effective and thus helps the firm to facilitate BUL activities. Not embedded BUL practices are not effective in facilitating BUL activities, so they only exist on paper.

After each of the BUL practices adopted by seven cases has been evaluated, a rating of the level of BUL embeddedness will be given to each case. The level of BUL embeddedness is a relative measure of how many embedded BUL practices have been adopted by cases in comparison to others. Three levels of ratings are given to those cases studied: good BUL embeddedness, moderate BUL embeddedness, and poor BUL embeddedness.

1.4 Research Method and Design

This research uses the multiple case study method to study four firms in China's automobile sector and three firms in its railway equipment sector. The seven firms in focus include four state-owned enterprises (SOEs) owned by the central government, two SOEs owned by local government, and one private limited firm.

Empirical data are qualitative data collected from 37 in-depth, semi-structured interviews with interviewees from seven companies between late 2015 and early 2016. Interviews were mainly high and mid-level managers in charge of R&D, quality management and HRM. These interviewees were chosen because they have sufficient knowledge of a firm's management practices including BUL practices so that they could provide appropriate information needed to answer the research questions. Some employees were also interviewed, when possible, to triangulate information given by managers.

1.5 Research contribution

Based on empirical findings, this research proposes two theoretical contributions to fill the knowledge gaps identified above.

Contribution to studies on China's NSI

This research formulates a theoretical framework consisting of four institutional factors to analyse and evaluate the impact of China's corporate governance system, firms' access to capital and market competition on firms' BUL. The four factors include: 1) whether the top manager of a firm is an insider or outsider, 2) the length of the top manager's employment, 3) the firm's access to capital, and 4) the level of market competition.

The first three factors are based on combining the finance and corporate governance (F&CG) model developed by Tylecote and his colleagues (e.g. Tylecote and Conesa, 1999; Miozzo and Tylecote, 2001; Tylecote *et al.*, 2002; Cai and Tylecote, 2005; Tylecote and Ramirez, 2006; Liu and Tylecote, 2016) with the network-based resource capital model created by Peng *et al.* (2005) and Yiu and Lau (2008:36).

During the data analysis, it was found that the research findings could not be fully explained by the first three factors. Further analysis found that the level of competition faced by firms has a significant influence on the level of BUL embeddedness of firms. By adding a market competition factor, the research findings could be fully explained.

Therefore, this research contributes to the existing literature by adding a market competition factor to the F&CG framework, to explain the level of BUL embeddedness of firms. This four-factor framework contributes to studies on the interaction between China's NSI and firms' innovation activities by explaining how CG, firms' access to capital and market competition influence firms' BUL.

Contributions to the literature on corporate governance and firms' innovation performance

This research contributes to studies on China's SOEs by distinguishing between the central SOEs and local SOEs in terms of how China's NSI influences their BUL practices. Existing studies on China's SOEs tend to group central SOEs and local SOEs into one category, which suggests their management and innovation activities are under the same, or similar, influences from China's NSI. However, this research argues that China's NSI has a distinctive impact on central SOEs and local SOEs which leads to different levels of BUL embeddedness.

Contribution to BUL literature

This research contributes to the BUL literature by initiating efforts to operationalise the concept of BUL to make it a practical management tool for developing an innovation capability in firms. This research identified five types of BUL practices from seven cases in focus and explained how the BUL practices are implemented in those cases. Moreover,

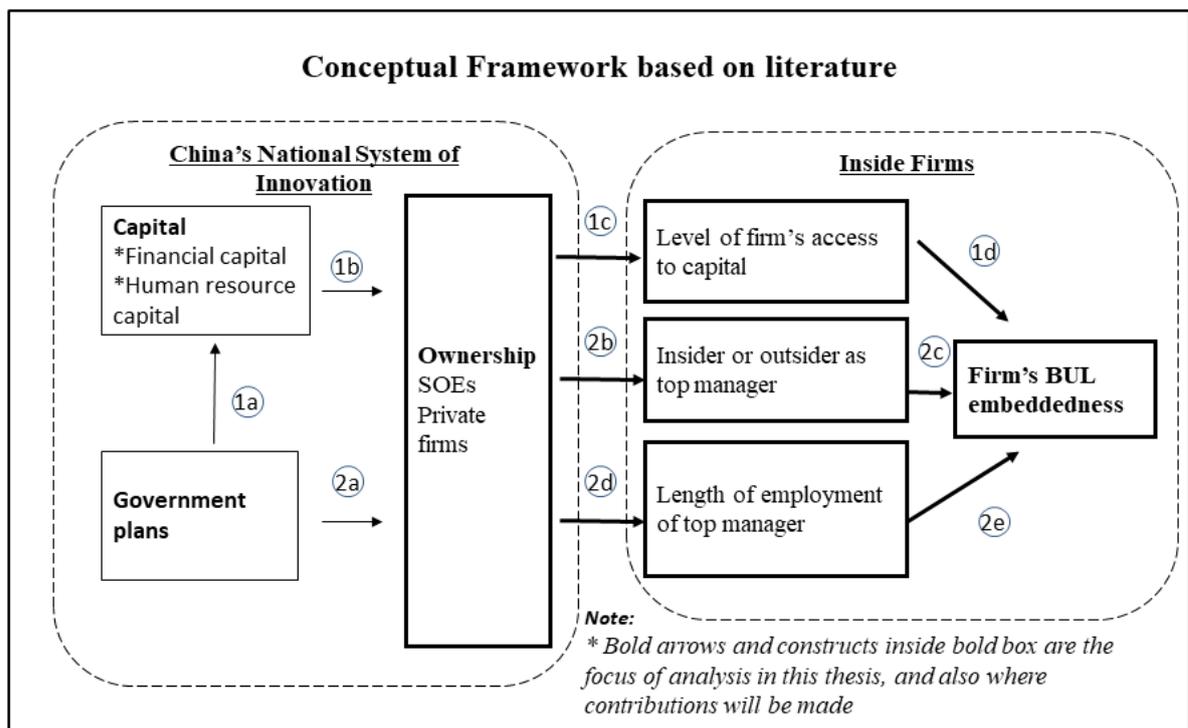
criteria for evaluating the embeddedness of BUL practices have been developed from the literature, which can be used in future research.

1.6 Research method and conceptual framework

This research uses a multi-case study method to address the research questions with qualitative data collected from in-depth semi-structured interviews. 37 respondents from seven Chinese firms were interviewed.

A conceptual framework is developed based on the literature to guide this research. (See Illustration 1-1)

Illustration 1-1: Conceptual framework based on literature



Link 1a and link 1b denote the impact of government plans on what capital is provided to firms having different ownership, namely SOEs and private firms. SOEs and private firms

will receive both financial and human resource capital from the government, but to different levels.

Link 1c denotes that the ownership of a firm influences the firm's access to capital.

Link 1d denotes that the level of the firm's access to capital could influence the firm's BUL. Link 2a denotes that government plans influence the corporate governance of SOEs by appointing a top manager directly by SASAC.

Link 2b denotes that the government could appoint either an insider or an outsider as top managers to SOEs. If the top managers do not have firm-specific knowledge before he/she is appointed, he/she is considered as an outsider. On the contrary, if the top manager has rich firm-specific knowledge when he/she is appointed, he/she is considered as an insider.

Link 2c denotes that the level of the top manager's firm-specific knowledge could influence their tendency to adopt embedded BUL practices. Firms with outsider top managers are likely to have a low level of BUL embeddedness. Conversely, firms with insider top managers are likely to have a high level of BUL embeddedness.

Link 2d denotes that the government could appoint the top manager for either short-term or long-term employment. If the top manager remains in position for more than ten years, he/she is considered as being appointed for the long-term.

Link 2e denotes that the length of a top manager's employment could influence the firm's BUL. This link explains whether top managers have the incentive to adopt BUL practices. Firms with short-term top managers are likely to have a low level of BUL embeddedness. Firms with long-term top managers are more likely to have high level of BUL embeddedness.

It needs to be noted here that, the government cannot appoint top managers to private firms. However, private firms still have the problem denoted by links 2c and 2e. An insider or outsider top manager in private firms, being appointed by shareholders for short-term or long-term, are still likely to face similar problems as indicated by links 2c and 2e.

The focus of the analysis is on constructs marked by the bold boxes and the interaction amongst them marked by bold arrows in Illustration 1-1.

1.7 Structure of the thesis

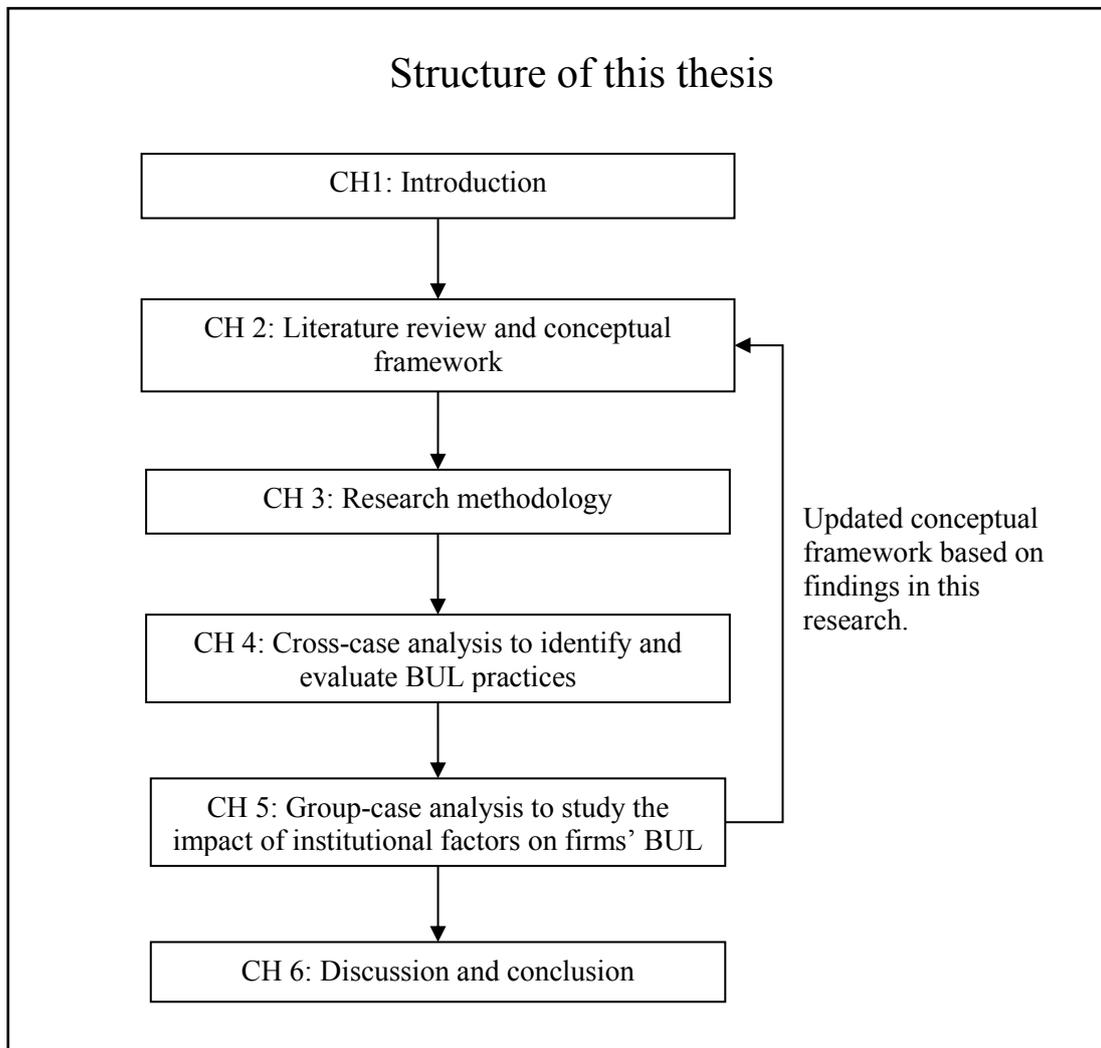
This thesis is structured as follows. Chapter 2 reviews the literature on topics including innovation, BUL in different disciplines and NSI in developing countries. Based on the literature reviewed, a conceptual framework is developed and explained in detail.

Chapter 3 states the philosophical stance in this research and justifies why critical realism is an appropriate epistemology position for this research. In addition, the choice of the multiple case study method, and the case study research design, are discussed and justified. Moreover, the data analysis method, research validation tests and ethical considerations are discussed.

Chapter 4 addresses the first two research questions by using a cross-case analysis method to identify and evaluate the BUL practices adopted in those firms studied.

Chapter 5 addresses the third research question by using the group-case analysis method to investigate the impact of two sets of institutions of China's NSI on firms' adoption of BUL practices.

Illustration 1-2: Structure of this thesis



Chapter 6 discusses the key research findings in the context of relevant literature and proposes three contributions to current knowledge. Moreover, the implications of this research to policymakers and management practitioners are proposed. Finally, the research limitations are discussed, and recommendations for future research are proposed accordingly.

Chapter 2: LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

2.1 Introduction

To develop a theoretical foundation for this research, this chapter discusses the existing literature on the relevant topics, namely technological innovation, bottom-up learning for innovation, and the national system of innovation. Moreover, this chapter develops a conceptual framework based on the literature in order to address the research objective.

This chapter is organised according to the fields of the literature reviewed as follows. Section 2.2 reviews studies on how the innovation is developed. Section 2.3 defines the concept of bottom-up learning (BUL) by discussing literature on what BUL is and how it contributes to innovation in firms. Section 2.4 discusses studies on China's national system of innovation (NSI) to develop a better understanding of how national institutions influence innovation activities at national, sectoral and firm levels. Section 2.5 develops a conceptual framework, based on existing literature, to investigate the impact of China's NSI on firm's BUL activities for innovation. Section 2.6 concludes this chapter by drawing useful insights from the current literature to guide this research in the following empirical investigation.

2.2 Innovation

The term "innovation" has various definitions in relevant literature. Schumpeter (1934) establishes the foundation for innovation studies by making a distinction between invention and innovation (Freeman and Soete, 1997). In the book *Business Cycles*, Schumpeter (1939) argues that innovation is the key driving force for the growth of capitalist economy because firms (mainly entrepreneurs) actively compete on developing innovations to gain competitive advantages.

Following Schumpeter's work, Freeman and Soete (1997) define innovation as a *new product* or a *new process of production* that has been commercialised. (Edquist, 1997:1) proposes that innovation could be entirely new to the world but is, more commonly, "a new combination of existing elements" that lead to economic development. Definitions made by Freeman and Soete (1997) and Edquist (1997) stress the commercial value and economic significance of innovation.

Thus, innovation literature mainly focuses on studying innovations that have a significant commercial and economic value. The focus of innovation studies was mainly towards new product development (NPD) and new ways of production. Terms like "*product innovation*" and "*process innovation*" have been used to describe those two types of innovation (Tidd *et al.*, 2005; Henderson and Clark, 1990). The process innovation refers to the introduction of new technologies and machinery into the original production process.

Furthermore, Edquist *et al.* (2001) recognise that a new way to organise the production process is also an important type of innovation, which could have a significant impact on economic development. Famous examples include Taylorism in Ford and Lean production in Toyota. Therefore, a clearer classification of innovation has been proposed (Edquist *et al.*, 2001). In this new classification of innovation, innovation includes product and process innovation. Process innovation includes *technological process innovation* and *organisational process innovation*. Product innovation includes *goods* and *service* (ibid).

However, not all innovations have significant economic value even though they are commercialised. For example, incremental innovations in the production process and

product design are commercialised innovations, but their economic value is less likely to be high. Therefore, such incremental innovations have not been widely studied in innovation studies until recently.

Fagerberg and Godinho (2005) defines innovation as the initial attempt to introduce a new idea into practice. This definition stresses the practical value of innovation instead of its economic value. It also suggests that innovation studies should pay more attention to understanding how innovations are developed.

Therefore, the following subsections review the innovation literature on studying the source of innovation, characteristics of innovation, and modes of innovation to develop a better understanding of how innovations are developed.

2.2.1 Source of innovation

Knowledge is widely recognised as the fundamental resource of innovation, and interactive learning is the key method to accumulate that knowledge (Dosi, 1988a; Lundvall, 1992; Freeman, 1994; Tidd *et al.*, 2005; Lundvall, 2010).

Knowledge used in innovation could be divided into three groups, namely external (to a firm) knowledge, internal (to a firm) knowledge and personal knowledge (Gibbons and Johnston, 1974). External knowledge is scientific knowledge acquired from the external environment including the purchasing of new product designs, introducing new technologies, collaboration with universities and so on. Internal knowledge is information managed within the firm including work-related records, blueprints, production manuals and so on. Personal knowledge is knowledge possessed by individuals including their previous education, training, work experience and so on.

Based on a study of 30 technological innovations in the UK around the 1970s, Gibbons and Johnston (1974) argue that only around 30% of information used in technological innovation is external knowledge.

Subsequently, a decade after Gibbons and Johnston's work, Pavitt (1984) points out that around 60% of knowledge input in technological innovations is from within firms. In addition, further research points out that around 40% of innovation activities are outside of formal research and development (R&D), especially in mechanical engineering sectors (Patel and Pavitt, 1994). Dosi (1988a) and Nelson (2004) also make similar arguments.

Internal and personal knowledge play crucial roles in innovation because innovation is fundamentally a problem-solving activity (Nelson and Winter, 1982; Bessant and Caffyn, 1997; Jensen *et al.*, 2007). Workers and engineers need to solve problems on a daily basis. Therefore, their knowledge repository will constantly update from daily trial-and-error. Therefore, it is reasonable to conclude that making good use of a company's internal and personal knowledge is critical to successful technological innovations.

One of the research interests in this thesis is to study how firms could use internal knowledge (e.g. production manuals, records, and so forth) and personal knowledge (e.g. education, training, experience, and so on.) to improve their innovation capability. To study these areas, this research identified a learning approach that focuses on facilitating employees to create and learn from internal and personal knowledge within a firm aiming to develop its innovation capability. This learning approach is labelled "Bottom-up learning (BUL)" and will be discussed comprehensively later in Section 2.3.

The recognition of the vital role played by internal and personal knowledge in innovation does not displace the importance of external knowledge (Gibbons and Johnston, 1974).

External knowledge remains crucial to success in innovation as it provides experience from other firms (also from the academic system and government research centres) in introducing contemporary technologies, and developing internal and personal knowledge (Patel and Pavitt, 1997).

2.2.2 Mode of innovation

To understand how innovations are developed within the organisation, Jensen *et al.* (2007) propose two modes of innovation. First, the “*science, technology and innovation* (STI) mode of innovation” (ibid: 680) that is to develop innovations by conducting R&D activities, or deliberate purchasing of codified knowledge. Second, the “*doing, using and interacting* (DUI) mode of innovation” (ibid: 680), which is to develop innovations by acquiring and accumulating knowledge from conducting daily operations, solving problems, operating machinery, and communicating internally between departments and externally with other firms and consumers.

The STI mode of innovation mainly creates new to the world and radical innovations. It features a high amount of R&D investment and intensive use of scientific knowledge (Jensen *et al.*, 2007) like biology and chemistry in the pharmaceutical industry. Therefore, the primary source of the STI mode of innovation is the development of the sciences. Indicators of the STI mode of innovation are the intensive R&D activities within firms and their collaboration with external research institutes (ibid). For example, the pharmaceutical industry spends an enormous amount of investment in laboratories to develop new medicines.

The DUI mode of innovation mainly creates incremental innovations. This mode of innovation is critical because Ettlie (1999) argues that the vast majority of modern innovations are incremental innovations. The DUI mode of innovation primarily relies on

the technological knowledge of how artefacts work (Nelson, 2004). Technological knowledge is accumulated from trial-and-error efforts in problem-solving by workers and engineers, at work, on a daily basis (Nelson, 2004; Nelson and Winter, 1982).

Experience and knowledge accumulated at work are mainly tacit, hard to articulate, difficult to transfer, easy to lose and highly embedded in the workforce (Freeman and Perez, 1988; Smith, 2001; Johnson *et al.*, 2002). Some research reports that about 90% of knowledge inside firms are embedded in their workforce (Wah, 2000; Lee, 2000; Smith, 2001). Moreover, innovation studies widely recognise the importance of knowledge developed at work by employees for developing innovations (Gibbons and Johnston, 1974; Pavitt, 1984; Patel and Pavitt, 1994; Dosi, 1988a; Nelson, 2004). For example, Lam (2002; Lam and Lambermont-Ford, 2010) argues that success in using tacit knowledge embedded in the workforce is one of the main reasons that explains the excellence of Japanese firms in engineering industries.

The DUI mode of innovation is of particular importance to this research because of its strong emphasis on the importance of employees' knowledge in developing innovations. The DUI mode of innovation is an important theoretical base of bottom-up learning for innovation (Andersen, 2008; Wei *et al.*, 2011).

2.2.3 Characteristics of innovations

The existing innovation literature shows that innovation has four characteristics (Fagerberg and Godinho, 2005). Firstly, novelty, the innovation is, to a certain extent, new. Secondly, cumulativeness, to innovate, knowledge accumulation is necessary. Thirdly, systemic, the process of developing the innovation is systemic ("collective" in some literature) in nature. Fourthly, uncertainty, the process and the outcome of

innovation activities are uncertain. The four characteristics of innovation will be discussed further in the following subsections.

2.2.3.1 Novelty of innovation and importance of incremental innovation

The novelty of innovation raises debate in economic studies in two admissions. First, the level of novelty of innovation. Second, the context of innovation (new to whom).

In the beginning, some scholars define the innovation as a new product, a new process that didn't exist before, or a new combination of existing components (Freeman, 1982; Edquist, 1997; Freeman and Soete, 1997). At this stage, innovation mainly accounts as being a radical and new to the world innovation (i.e. electricity and ICT technology). This is because economists mainly focus on evaluating the economic significance of an innovation to analyse how those innovations contribute to economic growth (Fagerberg and Godinho, 2005).

Therefore, most of the economic studies do not study an incremental innovation, which is mainly developed gradually in the production process and in the daily operation of organisations (Nelson and Winter, 1982). Examples of incremental innovations include improved production equipment, an improved production process, modification to tools, modification to existing products, and so on.

There could be two reasons for the lack of interest in studying incremental innovation. First, economists do not consider the incremental innovation to be valuable to economic growth (Johnson *et al.*, 2002). Secondly, because the incremental innovation is difficult to measure (Fagerberg and Godinho, 2005), being beyond the capability of the economic model. Economic models are mainly built through simplifying past events into

mathematical models, and they are not good at dealing with un-measurable (unquantifiable) factors (Nelson and Winter, 1982).

However, it is argued that incremental innovations are equally important as radical innovations (Lundvall, 1992) since the technological development following a radical innovation is still largely based on continuous incremental innovation in its production process and product design (Fagerberg and Godinho, 2005). Back in the 1930s, Schumpeter's work on economic growth also implied this phenomenon, although not explicitly. Schumpeter (1939) points out that radical innovation opens a new field of continuing improvement, which includes both radical and incremental innovations. Subsequently, this proposition is confirmed by Rosenberg (1994) based on the historical study of the development process of several industries.

Before a radical innovation can be used in practice, a series of incremental innovations are required in the production and design of the radical innovation (Kline and Rosenberg, 1986). It demonstrates that the vast majority of innovations in the modern economy are incremental innovations (6%-10% are radical innovations) (Ettlie, 1999). Historical evidence shows that production efficiency gained from continuous incremental innovations is usually much higher in the long run than what can be achieved through introducing radical innovation into the production line (Hollander, 1965). Moreover, radical innovation also requires the development of related technological fields (Fagerberg and Godinho, 2005), and changes in the institution where the innovation is embedded (Edquist, 1997; Edquist, 2005; Johnson, 2010).

Therefore, incremental innovations are crucial to both the economic growth and the technological development of the entire economy.

Another question is to whom the innovation is new. Developing countries generally focus on absorption, adaptation, and diffusion of technologies imported from industrialised countries, so traditional innovation theories, that focus on studying new to the world innovations, must adopt the broad meaning of innovation in order to study innovation and knowledge creation activities in developing countries (Lall, 2000; Viotti, 2002; Lundvall *et al.*, 2009). Therefore, “narrow” and “broad” definitions of innovation have been proposed (Lundvall *et al.*, 2009: 3). “Narrow” innovation means new to the world innovation (Pack and Westphal, 1986; Kim, 1997; Tidd and Bodley, 2002). Thus, the “narrow” definition is applied in studies of developed countries where radical innovations are normally developed. “Broad” innovation is what is new to the country or firm (*ibid.*).

This research adopts the “broad” definition of innovation because this research studies China, which is a developing country. Based on the “broad” definition of innovation, innovation in this research represents the first attempt to learn, adapt, improve, and diffuse existing technologies by subsequent countries and firms.

The debate around the novelty of innovation is of particular importance for developing the concept of bottom-up learning for innovation. This is because the incremental innovation, that adapts and improves existing technologies, is the underlying objective of the BUL approach (March, 1991; Lam, 2002; Mom *et al.*, 2006; Andersen, 2008; Aoki, 2008; Wei *et al.*, 2011). Because radical innovation is largely based on advancements in science (Dosi, 1988b), it is not likely to be developed by individual employees. However, employees could exploit their personally embedded tacit knowledge for developing incremental innovations during daily problem-solving processes at work (Andersen, 2008; Aoki, 2008; Wei *et al.*, 2011). Due to the cumulative characteristics of innovation, skills and experiences embedded in employees could be an important source of incremental

innovation for firms (Poell and Van der Krogt, 2003; Jensen *et al.*, 2007; Zoghi *et al.*, 2010; Lorenz and Lundvall, 2010). The cumulateness of innovation will be further discussed in the following subsection.

2.2.3.2 Cumulateness of innovation

The cumulateness (path-dependency) of innovation describes the evolving process of innovation development over time (Malerba and Orsenigo, 1997). The innovation is cumulative because the current innovation is usually developed based on other innovations that preceded it (Rosenberg, 1994; Pavitt, 1987; Dosi, 1988b).

Existing literature suggests that the cumulateness of innovation could be explained from two standpoints, namely: 1) the innovation developed in response to a company's demand for change and problem-solving in its daily work, and 2) the cumulative development process of innovation based on learning, which is a continuous and cumulative process. These two explanations will be further discussed in the following paragraphs.

Demand for change and problem solving The first standpoint is to understand why innovation emerges in relation to the demand for change in product and production processes. It points out that innovation emanates from the demands for change, which usually arise from encountering problems and failures in current product portfolios and production processes, so that firms initiate research activities to find solutions (Andersen, 1992).

This topic has been extensively discussed in a book by Nelson and Winter (1982) which reveals how creative solutions to problems become organisational routines, and how routines evolve after new problems are solved. Bessant and Caffyn (1997) also support

this proposition by pointing out that the innovation process is fundamentally a problem-solving process. Jensen *et al.* (2007) also make a similar argument.

In addition, the need for change could also be triggered by firms' who are ambitious to update existing products and gain efficiency in their production processes through introducing new technologies (Andersen, 1992). Another reason for a firm to search for innovations will arise from its market position being threatened, which leads to a search for new products, more efficient production processes and new markets (*ibid.*).

It is proposed that the direction of technological innovation is usually guided by the range of technical opportunities defined by the characteristics of existing technologies (Pavitt, 1987; Dosi, 1988b). This is because introducing technical changes into existing setups is not a costless process. It requires considerable investment by firms in terms of modifying their current technological designs of products and processes, as well as costs to acquire new knowledge around new technology for assimilation (Pavitt, 1987; Pavitt, 1999). Therefore, a firm's innovation is usually developed gradually through taking many small steps in upgrading its current technology base to avoid sudden and heavy investment. In addition, it is also important to introduce new technologies gradually because, Rosenberg (1994) proposed, that to understand and to effectively employ currently available technology (knowledge), people need to know how certain technology developed, which is the technical knowledge around this technology. If firms introduce radical, new technology into their production and new product development, they run the risk of lacking a sufficient knowledge base to understand and to assimilate the new technology (Fagerberg and Godinho, 2005).

Rosenberg (1994) also proposed that ideas for innovations are generated from previously accumulated scientific and technological knowledge bases. The knowledge base enabled innovators to develop multiple possible utilities or combinations of current technologies, within their capabilities (Dosi, 1988b).

Therefore, firms tend to fulfil the demand for change by searching for alternative technologies that are already close to its existing knowledge base (Lundvall, 2010). It is because of the assimilation of new technologies, based on its existing competency, that can accomplish more in a cheaper and faster manner when compared to introducing entirely new technologies that are far from those with which they are familiar (Pavitt, 1987). They will try to find alternatives far from their knowledge base if they are unable to find a satisfactory solution close to what they have already known (Lundvall, 2010).

Continuous Learning The second starting point to explain cumulativeness of innovation is to understand how innovation is developed. Lundvall (2010) argues that learning is the dominant process to acquire knowledge, and knowledge is an essential source for innovation (Tidd *et al.*, 2005). In addition, it is argued that innovation is a “ubiquitous phenomenon” (Lundvall, 2010: 8) because learning takes place all the time, knowledge is accumulated gradually by learning throughout time (Pavitt, 1987; Dosi, 1988b).

Moreover, the “technological trajectory” theory created by Dosi (1982: 154) proposes that the technological trajectory represents a group of potential directions of technology development that are not separable from the common technological base shared in one sector. This argument suggests that the direction of innovation, especially that of technological innovation, is usually guided by the range of technical opportunities defined by the characteristics of existing technologies (Pavitt, 1987; Dosi, 1988b). This is because

an employee's daily experience of the present technology influences the direction of their technological opportunities regarding research activities (Lundvall, 2010; Tidd *et al.*, 2005). What is more, the experiences from the shop floor also serve as an important source of knowledge for innovation (Nelson and Winter, 1982; Freeman and Perez, 1988; Lundvall, 2010; Freeman and Soete, 1997; Tidd *et al.*, 2005). Therefore, the product and process innovations that can be developed by firms depend heavily on previous achievements (Nelson and Winter, 1982; Pavitt, 1987; Teece, 1988).

Daily experience is a major knowledge base for innovation acquired from three sources, namely "learning by doing" repetitive work to improve efficiency (Arrow, 1962). "Learning by using" and operating complex machinery and equipment (Rosenberg, 1982), and "learning by interacting" with customers and suppliers (Lundvall *et al.*, 1988). The experience embedded in workers is very important because "much of the practice in most fields remains only partially understood, and much of the engineering design practice involves solutions to problems where professional engineers have learned 'work' without any particularly sophisticated understanding of why" (Nelson, 2004: 458).

To sum up, cumulateness of innovation emphasises the importance of having a continuous learning approach, like BUL, that could integrate employees' experiences and knowledge into innovation development. Such a learning approach, which uses employees' experience as one of the primary sources of knowledge, could help the firm to develop its technological innovation capability by allowing low-level employees to contribute their daily experiences into those processes, such as in creative problem solving, production process improvement and new product development.

2.2.3.3 Systemic

The systemic feature of innovation means that innovations are not developed independently. Innovation is systemic for two reasons. Firstly, innovation is an outcome of interactive learning, which is a collective process, it requires interaction across different organisations at sectoral level, and amongst employees at the firm level (Nelson and Winter, 1982; Lundvall, 1992; Fagerberg and Godinho, 2005; Tidd *et al.*, 2005; Lundvall, 2010). Secondly, innovation is usually generated within a domain of intrinsically related technologies, as an accumulation of innovation and “technology trajectory” (Dosi, 1982) theory suggested, innovation is usually closely linked to old technologies.

Collective learning As discussed previously, innovation is the outcome of learning (Dosi, 1988b; Freeman, 1994; Tidd *et al.*, 2005; Lundvall, 2010). Because learning is a social and interactive process, it is difficult to understand it in isolation from its context, whereas learning and innovation processes are embedded (Nelson and Winter, 1982; Fagerberg and Godinho, 2005; Lundvall, 2010).

Invention requires sufficient “knowledge, capabilities, skills and resources” (Fagerberg and Godinho, 2005: 5) before it transforms into innovation in practice. In addition, the process of innovation not only requires the input of technical knowledge regarding existing innovations, but also requires a collective effort from various parties (Van de Ven *et al.*, 2008). Furthermore, the development of innovation is also highly dependent on the characteristics of the technology, the industry (Freeman, 1982), and other causes, such as institutions where those innovation activities are located (Johnson, 2010; Fagerberg and Godinho, 2005).

The interrelation between innovation and old technology Studies of innovation often apply a systemic perspective because innovation is also an accumulative process and, much of which, gradually emerges from existing interrelated innovations. As suggested by the “technological trajectory” theory, the vast majority of new technical advancements have inextricable linkages to old ones (Dosi, 1982: 148; Fagerberg and Godinho, 2005; Lundvall, 2010: 9). Therefore, to develop a firm’s innovation capability, the firm needs to accumulate a sufficient base of scientific and technological knowledge before it can either understand new technological innovations in the market, or develop its own (Fagerberg, 2005).

The systemic perspective of innovation is the foundation for national systems of innovation (NSI) studies (Freeman, 1987; Lundvall, 1992; Nelson, 1993; Edquist, 1997). The NSI literature primarily studies innovation activities by various actors (organisations) (e.g. firm, university, and so on), and relationships amongst actors that are shaped by institutions (Lundvall, 2010; Fagerberg and Godinho, 2005; Edquist, 1997; Freeman, 1987). This group of NSI literature will be discussed in detail later, in Section 2.4.

The systemic nature of innovation suggests that innovation requires an environment of collective learning and a good knowledge base of existing technology. The collective learning process is critical since it facilitates learning either from other parties externally, or amongst employees internally, to develop a firm’s knowledge base.

For collective learning amongst employees, it is important to consider who will be included in this learning process. In the late 1950s, collective learning from experience was already being considered as an important organisational activity that influences a firm’s innovation capability (Penrose, 1959). However, Penrose (1959) mainly focusses

on the collective learning process amongst managers. Later in the early 1990s, Best (1990: 134) suggested “non-managerial” employees should also be included into the collective learning process, because the advantage of firms originates from its employees’ “teamwork and knowledge creation” based on successful experiences in Japanese firms. Furthermore, Lazonick (1990) argues that sustainable competitive advantage is determined by a firm’s capability of collective learning at the shop floor level, which is critical in the development of knowledge of how to combine and use resources in ways that rivals cannot. Thus, it is important to include both management and non-management employees in the collective learning process.

This argument is crucial to justify the BUL approach for developing innovation capability, because the BUL approach particularly stresses the demand for involving shop floor employees into the knowledge creation and innovation process in firms.

2.2.3.4 Uncertainty

During the innovating process, outcomes of research activities are unknown (Nelson and Winter, 1982; Dosi, 1988a). Because the process of innovation has a strong randomness within it (Lundvall, 2010), firms tend to avoid heavy investment in R&D due to risk avoidance of the decision makers. O’Sullivan (2000) argues that innovation has two types of uncertainty. First, “productive uncertainty” which reflects the high risk of making a loss on investment in any R&D projects if they fail (ibid: 19). It is because the returns on the innovation can only be generated after success has been achieved in such projects. Secondly, “competitive uncertainty” which means that although a firm has successfully developed innovations, its new outcomes could potentially be outperformed by what rivals have developed at the same time (ibid). Therefore, the firm still could not generate a return in such a scenario.

Although the innovation has inherent risks, it is required for firms to survive, especially in a capitalist economy where competition forces firms to develop competitive advantage through continuous innovation (Rosenberg, 1992; Freeman, 1995). In a capitalist economy, firms constantly face pressure from rivals to improve their product quality and lower their production costs (O'Sullivan, 2000).

Another insight from understanding the uncertain nature of innovation is that firms should not rely solely on formal R&D activities to develop innovations. First, the success of any formal R&D activities is not guaranteed, but the cost is high. Second, sectors differ in their technological base, so some sectors rely more on radical innovation (advancement in science), while others rely more on incremental innovation (Pavitt, 1984). Therefore, firms need to have different learning approaches according to the characteristics of their technological base. For high-tech sectors, such as the pharmaceutical industry, science-based research in formal R&D projects are more important (O'Sullivan, 2000; Tylecote and Ramirez, 2006). However, in mid-high-tech sectors, like the automobile industry, innovations are mainly developed from the employees' learning along with the problem-solving process (Tylecote and Visintin, 2008; O'Sullivan, 2000).

Therefore, firms need to have management practices in place to manage and utilise employees' work experience and personal embedded knowledge (mainly in the form of tacit knowledge) as a source for innovation, because learning and knowledge creation happens all the time but can easily pass unnoticed (Freeman and Perez, 1988). The BUL approach is a tool for this task, which will be discussed comprehensively in Section 2.3.

2.2.4 Remarks on the innovation literature

This section reviews innovation literature in three topics, namely 1) source of innovation, 2) mode of innovation, and 3) characteristics of innovation. A review of innovation literature shows three research gaps.

It is found from the literature that the importance of incremental innovation has been widely recognised by scholars, especially in the study of engineering sectors. This finding underpins one of the research interests in this thesis, that of promoting the bottom-up learning (BUL) approach, which aims mainly to develop incremental innovations in engineering sectors.

Moreover, it is found in the literature that engineering sectors primarily rely on the DUI mode of innovation. This mode of innovation mainly produces incremental innovations using technological knowledge about how artefacts work. It is also found that technological knowledge develops, primarily, through problem-solving activities at work by workers and engineers and on a daily basis. This finding shows that the BUL, which aims to facilitate interactive learning amongst employees and encourages creative problem-solving activities on the shop floor, is an appropriate learning approach for sectors that rely on incremental innovations in the production process and in product design.

In the next section, the literature on bottom-up learning will be reviewed to define this concept and to develop a better understanding of the topic.

2.3 Bottom-Up Learning for Innovation

The concept of “bottom-up learning” (BUL) proposed in this paper is defined as: knowledge creation, learning and sharing activities by shop floor employees to produce creative solutions to problems, or to develop process and product innovation.

This definition is developed based on summarising existing literature (March, 1991; Bessant and Caffyn, 1997; Lam, 2002; Mom *et al.*, 2006; Andersen, 2008; Høyrup, 2010; Wei *et al.*, 2011; Lee and Walsh, 2016) relevant to this topic, all of which will be discussed in detail in the Section 2.3.1.6.

Section 2.3.1 reviews the literature on the importance of BUL in firms’ innovation process to discover the theoretical foundation of BUL. Based on this selection of literature, the concept of BUL will be defined for further analysis in this research. Section 2.3.2 reviews literature from four disciplines including knowledge management (KM), organisational learning (OL), human resource management (HRM), and operation management (OM) to identify BUL practices. Section 2.3.3 discusses the literature that studied the interplay between BUL and the innovation capability of firms. Section 2.3.4 draws insight from the literature to guide the empirical investigation in this research of studying BUL in firms.

2.3.1 Define Bottom-up learning

As discussed in Section 2.2.1 the personal knowledge repository of employees is a major source of innovation (Gibbons and Johnston, 1974; Pavitt, 1984; Bessant *et al.*, 1994; Bessant and Caffyn, 1997). Advocates of this argument state that developing a receptive environment for employees to actively propose suggestions on product and process innovation is a key approach to improve firms’ innovation performance (March, 1991; Bessant and Caffyn, 1997; Lam, 2002; Mom *et al.*, 2006; Andersen, 2008; Høyrup, 2010; Wei *et al.*, 2011; Lee and Walsh, 2016). Because those scholars discussed this learning

approach from various angles, they used different terms. Terms used in the BUL literature are summarised in Table 2-1.

Table 2-1: Summary of terms used in the BUL literature

Author/s	Year	Term	Focus of research	Background
March	1991	Exploitive innovation	Develop innovation using internal resources and knowledge base.	Strategy
Bessant and Caffyn	1997	High involvement innovation	Involve all employees in continuous improvement events to develop incremental innovations in a costless manner.	Operation management
Lam	2002	J-form organisation	Innovation developed from collective problem-solving. Disseminate personal knowledge across workforce to develop collective knowledge.	Organisational learning and Knowledge management
Mom <i>et al.</i>	2006	Bottom-up knowledge inflow	Use suggestions from employees to identify innovation opportunities to develop product and process innovation.	Strategy
Anderson	2008	Bottom-up perspective on innovation	Develop innovation by recombining existing resources, knowledge, and capabilities within the firm.	Organisational learning and Strategy
Høyrup	2010	Employee-driven innovation	Incremental and radical innovations developed by employees at work through the DUI mode of innovation.	HRM
Wei, Yi and Yuan	2011	Bottom-up learning	Information gathered from shop floor employees for managers to identify innovation opportunities.	Strategy
Lee and Walsh	2016	Non-R&D learning	Innovation based on the knowledge development at work through problem-solving	HRM

The summary of BUL related literature shows that scholars studied the topic of utilising employees' knowledge to develop innovation from various angles. Five groups of

literature could be identified based on their disciplines, namely strategic management, knowledge management (KM), organisational learning (OL), human resource management (HRM), and operation management (OM). These five groups of BUL literature will be discussed in the following sub-sections.

2.3.1.1 Bottom-up learning in strategic management

The strategy of firms is defined by Nelson (1991: 61-74) as “the set of broad commitments made by a firm that defines and rationalises its objectives and how it intends to pursue them”. Following his argument, the strategy has a profound influence on the development of innovation activities in the firms. It is because the strategy determines where firms invest their resources and how resources are allocated to different innovation activities (O'Sullivan, 2000).

Aiming to address the dilemma of allocating a limited resource into refining existing competence or exploring new technology, March (1991) proposed the concept of exploitation – refining and improving current competence to develop incremental innovation, and exploration – searching for and experimenting with new technologies to develop more radical innovations. It is suggested that firms need to exploit current competence to maintain competitiveness in the short-term, whilst at the same time, exploring new technological opportunities for long-term survival (March, 1991; O'Reilly and Tushman, 2013). However, being an ambidextrous organisation that masters both exploitation and exploration is not an easy task for firms, as it requires sufficient capacity to carry out structural changes to be able to embrace new technologies (Tushman and O'Reilly III, 1996).

O'Reilly and Tushman (2013) suggested that in order to develop ambidexterity, structural change in a firm is needed, which relies on a dynamic capability as proposed by Teece *et*

al. (1997) and Teece (2007). Dynamic capability theory argues that firms' competitive advantage depends on their capability to restructure an existing resource or to develop new capabilities to address rapid changes in technology and customer demand (Teece *et al.*, 1997; Teece, 2007). It has been argued that firms maintain their competitiveness through exploitation at an early stage and transform towards exploration at a later stage (O'Reilly and Tushman, 2013). Two major approaches for firms to develop ambidextrous capability have been proposed (*ibid*).

First, the structural change approach – firm maintains current competitiveness and achieves flexibility to adapt to market and technological changes through introducing new management structures/practices, such as decentralisation, to form autonomous innovative sub-units to encourage experimentation with new technologies (Eisenhardt and Martin, 2000; Siggelkow and Levinthal, 2003; O'Reilly and Tushman, 2013).

Second, the cultural change approach - firm maintains current competitiveness and achieves flexibility to adapt to market and technological changes through developing an organisational culture that encourages risk taking and decision making in improving old work routines and introduces small-scale, new technologies at individual (worker) level (Gibson and Birkinshaw, 2004). In this approach, the culture of firms allows individuals, rather than innovative sub-units as mentioned in the structural approach, to make the choice between exploitation and exploration at work (O'Reilly and Tushman, 2013). The Toyota Production System is an excellent illustration of the cultural change approach to ambidexterity as it develops a widely shared culture within the firm that encourages workers to become increasingly competent in routinised tasks (exploitation), at the same time, actively exploring new ways of doing work efficiently (exploration) (Adler *et al.*, 1999).

Both the structural change approach and the cultural change approach toward building ambidextrous firms emphasises the importance of the transformation of the firm from a top-down, centralised, decision-making system, to a more bottom-up, decentralised decision-making system. In the structural change approach, decision-making and risk-taking, when engaging in new technological fields, are delegated from top management to innovation sub-units. Therefore, the innovation outcome, either those radical innovations from exploitation. or incremental innovations from exploitation, generated by the innovative sub-unit at the lower level of the firm, will eventually feedback to firm level. In the cultural change approach, the power endowment went even further down to the level of the individual, which allows everyone to actively engage in exploration within his, or her, competence at work.

Individuals are limited from carrying out too much exploration and are unable to make any significant changes in the firm due to their lack of expertise in any new technological fields, and any power they might otherwise have is handicapped by their low ranking in the firm. In this situation, sufficient training for the workforce in any new technological fields, and having supportive top management who can provide legitimacy for change, are critical in ambidextrous firms (O'Reilly and Tushman, 2013).

To sum up, in order to develop innovation capability through exploitation and exploration, firms need to delegate decision-making for making change to the lower levels of organisation.

However, one drawback of the strategic management literature is that it only provides abstract suggestions stating that structural and cultural changes are needed to develop ambidexterity, however, it fails to illustrate what the firm looks like before and after any

change (O'Reilly and Tushman, 2013). How do firms manage to solve the conflict between exploitative and exploratory activities? What resources are required for developing exploitative (incremental) and exploratory (radical) innovations? Answers to these questions are found mainly in the strategic literature. Therefore, the literature concerning knowledge management (KM) and organisational learning (OL) needs to be explored in the next sub-section, because knowledge is the key resource for innovation (Dosi, 1988b; Lundvall, 1992; Freeman, 1994; Tidd *et al.*, 2005). KM and OL research precisely studies how knowledge is developed, shared and managed within firms.

2.3.1.2 Bottom-up learning in Knowledge Management

Knowledge management (KM) does not have a unified definition amongst academics. It is usually described in a variety of ways across many papers. Several papers define KM as a series of knowledge acquiring, developing, managing, diffusing and applying activities (Coombs and Hull, 1998; Probst *et al.*, 1999; Alavi and Leidner, 2001). Some researchers consider knowledge as an asset and try to maximize the return from it (Wiig, 1997). Davenport and Prusak (1998) pointed out that KM aims to process knowledge and makes it available to people who need it (King, 2009) and facilitate the exploration and exploitation of the knowledge repository (Swan *et al.*, 1999). Although many definitions of KM exist, various definitions of KM propose some common features of the KM process that are the creation, storage and diffusion of knowledge within the organisation.

In addition, the linkage between successful KM practice and strong innovative capabilities of firms have been found in much research through quantitative methods (March, 1991; López-Nicolás and Meroño-Cerdán, 2011; Cantner *et al.*, 2011) and qualitative case studies (Hoegl and Schulze, 2005). However, most of the studies that analyse the interplay between KM and innovation performance focus mainly on how to

increase the efficiency of knowledge utilisation during innovation development. They consider KM practices as the main tool for sharing knowledge, but fail to recognise such KM practices could also facilitate the generation of innovative ideas at the individual level through BUL. As discussed previously, personal knowledge and internal (within the firm) knowledge are the largest components of knowledge used in successful innovation (Gibbons and Johnston, 1974; Pavitt, 1984; Dosi, 1988b; Nelson, 2004). It is important to encourage employees to actively explore their personal and internal knowledge base and to come up with creative solutions to problems or ideas for new products, in which case the knowledge management practice plays a critical role in allowing for efficient knowledge sharing and utilisation. Therefore, in this research, KM is recognised as a critical tool for developing bottom-up learning for innovation in firms. In addition, KM theories also provide a strong theoretical background for bottom-up learning for innovation by identifying what types of KM approach promote knowledge sharing and utilisation at the individual level, and also promote innovation.

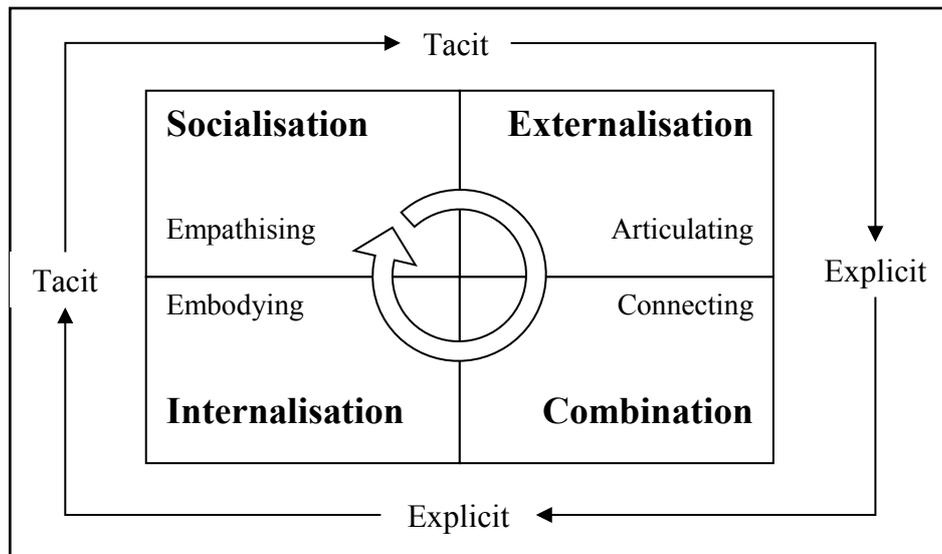
Based on Hansen *et al.* (1999), two approaches to KM could be distinguished. The first approach is the *codification strategy* (ibid) (the *system-oriented approach* in Choi and Lee, 2003). This approach focuses very much on using explicit knowledge (Davenport and Völpel, 2001; López-Nicolás and Meroño-Cerdán, 2011) and the intensive use of information technology (IT), the technology (Martini and Pellegrini, 2005) to extract knowledge from its developer and to carefully codify and sort it into a database for other members to use (Armstrong, 2006). The second approach is *personalisation strategy* (Hansen *et al.*, 1999) (the *human-oriented approach* in Choi and Lee, 2003). This approach is more concerned with the use and sharing of tacit knowledge (Davenport and Völpel, 2001; López-Nicolás and Meroño-Cerdán, 2011). Personal interaction, like

conversations or face-to-face meetings, are the main methods of sharing knowledge in this setting. Knowledge seekers are encouraged to make direct contact with the original knowledge developer through formal (i.e. meeting, workshop, etc.) and informal (i.e. organisation's day out, personal relationships, etc.) events (Armstrong, 2006).

Choi and Lee (2003) have proposed another two types of KM approach, which is the *passive approach* and the *dynamic approach*. The Passive approach simply means no formal knowledge management system has been applied in the firm. A dynamic approach is a combination of system-oriented and human-oriented approaches in order to balance the use of codified and tacit knowledge within the organisation for better effectiveness of knowledge management (Piorowski *et al.*, 2013). It is found that the dynamic approach produces the best innovation performance over any other KM approaches (Choi and Lee, 2003). The dynamic approach by Choi and Lee (2003) is developed based on the dynamic spiral of knowledge creation developed by Nonaka (1994), which transfers knowledge from tacit to explicit and back to new tacit knowledge through a continuously improving and refining process.

The book *The Knowledge Creating Company* by Nonaka and Takeuchi (1995) is based on case studies of successful Japanese engineering and manufacturing firms in the 1970s and 1980s. The most famous model in this book is the knowledge creating spiral model (Armstrong, 2006), which explains how Japanese firms successfully transfer personal embedded tacit knowledge to explicit knowledge shared by others and creates new tacit knowledge after an internalisation process ("learning-by-doing") (Nonaka and Takeuchi, 1995: 69).

Illustration 2-1: Knowledge creation spiral



Source: Adapted from Nonaka, 1994

The “spiral model of knowledge creation” contains four steps to convert knowledge (Nonaka, 1994: 15) (as shown in Illustration 2-1). Firstly, tacit knowledge is shared with others still in tacit form through the *socialisation* process. This idea is developed based on organisational cultural studies (Nonaka and Takeuchi, 1995). In addition, this socialisation process is mainly in the form of informal events (Hoegl and Schulze, 2005) that encourage face-to-face interaction between employees to transfer tacit knowledge. At this stage, knowledge is transferred through direct “observation, imitation and practices” with other members of the organisation (Nonaka and Takeuchi, 1995: 69) like apprenticeships and on-the-job training.

The second step is to convert tacit knowledge to explicit knowledge through the *conceptualisation* of ideas into language. In this way, employees are forced to express the ideas in their minds using words to articulate the tacit knowledge. This stage could have serious problems in low-context countries where the language expresses precise meaning without having much room for speculation of hidden meaning (Hoegl and Schulze, 2005).

However, in high context countries like Japan and China, much hidden meaning exists behind what has been said (ibid). This is one of the main reasons why Japanese firms successfully conceptualise their personal tacit knowledge into personal explicit knowledge through using metaphors and analogies to describe the ideas they have in mind (Nonaka and Takeuchi, 1995). The key challenge here is to ensure that the learner understands what the storyteller is saying by having a shared mental model amongst employees (ibid).

The third step is to share explicit knowledge amongst organisation members and to further improve the value of it by a combination process. *Combination* process means an employee combines explicit knowledge from various sources or domains to create a working solution for the problem encountered (ibid). This step would facilitate incremental innovations by combining any existing knowledge in a new way to produce creative solutions to a problem.

The final step is to link explicit knowledge acquired to the learner's tacit knowledge base through internalisation. Consequently, new tacit knowledge is produced at work via learning-by-doing and is transferred through *socialisation* (Nonaka and Takeuchi, 1995: 69), which also starts another round of the knowledge creation spiral.

In the Knowledge Creation Spiral, knowledge is shared in multiple ways at various stages. It ensures that knowledge is neither possessed by individuals nor top managers, but collectively owned by all members of the organisation.

This model emphasises the importance of exploiting the tacit knowledge on the shop floor and using it for further product and process innovation. Given this, the Knowledge Creating Spiral model provides a theoretical base of the idea of bottom-up learning for

innovation in the way that it proposes a way of utilising shop floor knowledge to benefit a firms' innovative performance, instead of purely focusing on using formal R&D to develop innovation.

The review of KM literature provides two implications to this research. First, the literature suggests that firms need to have a dynamic KM system to have the best innovation performance by utilising both explicit and tacit knowledge (Choi and Lee, 2003). Thus, firms should not overwhelmingly rely on a codification strategy, which mainly uses and produces explicit knowledge. Instead, the firm should also pay more attention to adopting practices that encourage the creation and sharing of tacit knowledge through adding a personalisation strategy to their KM system. Second, firms need to encourage and manage the creation and sharing of personal embedded tacit knowledge to make it collectively embedded in the firm. This allows firms to retain and exploit their precious tacit knowledge base, which is the key to the excellence of the Japanese in engineering sectors (Nonaka and Takeuchi, 1995). Thus, firms need to have KM tools to facilitate personal interaction and face-to-face learning to help the individual employee to share tacit knowledge to other workers.

2.3.1.3 Bottom-up learning in Organisational learning

According to King (2009), organisational learning (OL) and knowledge management (KM) studies are complementary to one another. It proposes that KM aims to ensure that knowledge-related assets are well managed and deployed in such a way as to achieve the best efficiency of knowledge transfer (King, 2009), while OL is an extension of KM by studying how to ensure what has been learnt becomes organisational (collective) knowledge shared by members of an organisation to guide their behaviours (Levitt and March, 1988). Although it is pointed out that KM focuses more on the content of

knowledge within an organisation, but OL focuses more on the process of knowledge sharing amongst members of the organisation (Easterby-Smith and Lyles, 2003).

Various literature on organisational learning has studied how management styles (organisational structure) affect the innovative capability of the company. Leading work in this area include Lorenz and Lundvall's work on measuring the creativeness of European countries (Lorenz and Lundvall, 2010; Arundel *et al.*, 2007), Lam's works on knowledge sharing and organisational learning (Lam, 2000; Lam, 2005; Lam and Lambermont-Ford, 2010).

With the development and wide diffusion of the Japanese management style, the linkage between organisational forms and innovation became a popular topic in management studies. Various research has been conducted in order to reveal the relationship between how companies are managed and how innovative they are. In general, the work by Lorenz, Lundvall and Lam proposes four types of organisational structures based on work by Mintzberg (1979) and Mintzberg (1993).

The first type is the "Machine Bureaucratic" form of organisation (Lam, 2000: 494), which standardises and specialises work having clear job design and routines (Arundel *et al.*, 2007) to achieve efficiency in production (Lam, 2000). This form of organisation aims to minimise the disruption from its environment and its employees since all tasks are pre-set and the only role of the workers is to follow the code-book (Mintzberg, 1979). Therefore, this form of organisation relies heavily on codified knowledge and stores it centrally within the management structure, then develops standardised and shared routines across the organisation (Bonora Elda and Revang, 1993). However, because of such strong emphasis on the articulation of tacit knowledge, a significant amount of

information in tacit knowledge is lost during the codification process (Lam, 2000). Not all information is codifiable, and not all the codified knowledge can be understood by subsequent users of that knowledge (Johnson *et al.*, 2002). In addition, because this form of organisation is designed to minimise the influence of the employee, workers' opinions and creativeness are not encouraged as they pose potential disruption to the efficiency of production. Therefore, these organisations are criticised as not having a high level of employee involvement and are not innovative, thus are only suitable for low-tech sectors such as the textile industry (Lorenz and Lundvall, 2010).

The second form is the "Professional Bureaucratic" organisation (Lam, 2000: 494). This features relatively high levels of autonomy for the employee at work, but their jobs are still governed by routine and professional standards (Arundel *et al.*, 2007). Employees in this type of organisation usually have a high level of professional qualification, such as a degree in law, before joining the company. Thus, their behaviours are normally regulated by professional, standardised routines, despite any other managerial roles of their employers (Lam, 2000). Examples of this form of organisation could be professional consultancy companies in law, accounting and so on. Employees in this type of company are highly flexible as long as they follow general routines (e.g. the paperwork) because the content of their work is solving problems based on their professional knowledge and according to a client's requirement, which is rarely the same each time. Therefore, they have a relatively high chance of developing new knowledge due to this extensive and continual problem solving (*ibid*). Although there are great opportunities for those employees to develop new knowledge through daily work, there are issues with centralising and sharing that knowledge, especially tacit knowledge. This is because their knowledge is created on an individual basis, which is acquired during their daily work,

and this non-standardised (tacit) knowledge is difficult to share directly with others (ibid). Consequently, this type of organisation is not that innovative because a large amount of knowledge is kept to the employee, which is not going to help the organisation as a whole to improve its innovativeness. Companies would easily lose their knowledge repository if key employees left.

The third form of organisation is the “Operating Adhocracy”, in which the company forms temporary teams based largely on the nature of the assigned project (Lam, 2000: 494; Lam and Lambermont-Ford, 2010). This type of organisation usually has a much more level management hierarchy, so employees have more autonomy in the problem-solving process (Lam, 2000). In addition, because the team is composed of many experts with a mixture of skills and backgrounds, they are capable of solving problems collectively with their spread of expertise (Lam, 2000; Arundel *et al.*, 2007). In comparison to the former two types of organisation, operating adhocracy organisations are more creative because their employees are given a higher degree of autonomy to experiment with their own ideas to accomplish the project. Also, because they work in project teams, they would have interactions with other team members. Consequently, those interactions between team members and the creative trial-and-error activities could see the development of a great deal of tacit knowledge (Lam and Lambermont-Ford, 2010). However, that knowledge is hardly retained because the project teams will be dismissed at the end of each project (Lam, 2000). To sum up, the operating adhocracy form of organisation is very creative because of its interactive problem solving by team members with a range of expertise. However, a significant amount of tacit knowledge is lost because the project team will be dismissed team after the project is completed (ibid). An example of this form of organisation is that of construction firms who hire several

small contractors to work together on a large project. After the project is finished the contractors will leave.

The fourth type of organisation, which is also the most important one for the engineering sector, is the J-form (Japanese form) organisation proposed by Lam (2000, 2005, 2010). The knowledge base of the J-form organisation is stored across different task teams, which are formed by members having diverse functional capabilities. It is slightly similar to the operating adhocracy organisation that has different teams. However, the J-form organisation manages to maintain its valuable tacit knowledge. In the J-form organisation, knowledge is not held by individuals or by the central management hierarchy.

The knowledge has been transformed into shared values, cultural, common sense and routines widely shared across the entire organisation (Nonaka and Takeuchi, 1995; Lam, 2000). It is achieved by making employees work in different divisions to solve problems interactively with team members to create and absorb knowledge (both codified and tacit) and then return to their original positions after they have finished the *ad hoc* project (ibid). Thus, the tacit knowledge, which is usually possessed by individuals, is transformed into shared tacit knowledge in the J-form organisation, even though it may not remain codifiable. In addition, the life-long employment in Japan enables the company to retain the knowledge base for later use (Johnson *et al.*, 2002). Because the J-form organisation specialises in generating tacit knowledge through daily problem solving and the DUI mode of innovation, it outperforms other forms of organisations in developing continuous incremental innovation through improving its old knowledge repository (Lam, 2000). It is one of the main reasons why Japanese companies excel in the engineering sector (Freeman, 1987; Aoki, 1990; Womack *et al.*, 1991; Arundel *et al.*, 2007; Lam, 2000).

This is due to the continuous improvement in product design, production processes and quality that are crucial in the engineering sector.

Both Operating Adhocracy and J-form organisations use multi-disciplinary teams at work. The difference is that team members in the J-form organisations will remain in the firm after the team is dismissed. Whilst teams functioning in an operating adhocracy rely on temporary teams of experts who will leave the firm after the project ends.

From the review of the OL literature, it is found that the superior capability of the J-form organisation in creating, utilising and managing employees' knowledge is of particular interest in this research.

Although this area of the literature did not focus particularly on studying "bottom-up" issues. However, how firms utilise knowledge from their employees and what the impact is on the creation of codified and tacit knowledge, is an important part of the research objectives. Therefore, this area of literature provides theoretical support for understanding how and why BUL works in firms. It also helps with rationalising the importance to adopt BUL as an important part of a firm's knowledge creation and innovation activities. J-form organisations have a special advantage in creating tacit knowledge, and further retain this part of knowledge for future use (Lam, 2000, 2002, 2005).

Because tacit knowledge is difficult to transfer into explicit knowledge, J-form organisations transfer individual tacit knowledge into collective tacit knowledge by letting workers solve problems in teams so that they might develop shared norms amongst the workers (ibid). Then those workers rotate to other groups to allow other parts of the organisation to learn from them, thus enabling them to learn what has been developed in those teams as well.

Since bottom-up innovation requires active employee engagement in problem-solving, and creation and use of tacit knowledge, the J-form organisation would be the most favourable form of management style that promotes the development of BUL for innovation. This is because the J-form organisation could not only encourage knowledge creation, but also retain it and use it for improving products or for refining production processes. Although, professional bureaucratic and operating adhocracy organisations encourage tacit knowledge creation through problem solving in a similar way to the J-form organisation, these two types of organisation fail to maintain and utilise that knowledge in their daily operations.

However, the J-form organisation also has its limitations because it is not suitable for firms in high-tech sectors.

As discussed earlier in Section 2.2.2, sectors rely on different forms of knowledge and different modes of innovation. High-tech sectors primarily rely on explicit scientific knowledge, whilst mid-high-tech sectors rely more on tacit and technological knowledge. Therefore, the J-form organisation is preferred in engineering sectors, which are mostly mid-high-tech sectors.

However, the J-form organisation has limited capability to develop radical innovations. The J-form organisation relies primarily on tacit knowledge created by employees at work. In addition, it uses lifetime employment as a tool to retain its knowledge base. These types of organisation may have a superior performance in innovation when the technological base of their sector is relatively stable. In an environment where technology evolves rapidly, the J-form organisation would not be suitable.

As discussed in Section 2.3.1.1, firms need to develop a dynamic capability to respond to rapid change in the industrial environment (Teece *et al.*, 1997; Teece, 2007) otherwise they will lose their competitive advantage. With a large amount of knowledge embedded within the workforce, and using lifetime employment to retain its knowledge base, a J-form organisation is likely to be rigid in structure and therefore is not capable of coping with rapid change in the knowledge base of its sector. For example, electric vehicle technology poses a significant threat to conventional car manufacturers because the underlining technology of the automobile sector is shifting from the internal combustion engine to electronic motors. These two technologies depend on different scientific knowledge bases, which could make the embedded knowledge of J-form car manufacturers obsolete.

2.3.1.4 Bottom-up learning in Human Resource Management

The HRM literature stresses the importance of the role played by employees in innovation. It is argued that because the key contributor of BUL is the workers, how workers are managed and supported by top managers has a direct impact on the effectiveness of the bottom-up learning process (Kesting and Parm Ulhøi, 2010; Høyrup, 2010).

As discussed in various sections before this, the core foundation of innovation is learning, which is knowledge creation within the workforce (Dosi, 1988; Lundvall, 1992/2010; Freeman, 1994; Tidd, Bessant and Pavitt, 2005). This points out that any technological innovation of firms is mainly developed internally by employees who, effectively, learn at work (Pavitt, 1990; Li *et al.*, 2006). Building an active learning environment inevitably requires high involvement of employees in the innovation process which is the foundation to BUL.

Employee involvement and participation in general means to also increase the level of employee involvement in decision making (Doeringer *et al.*, 2003; Lorenz and Wilkinson, 2003; Armstrong, 2006) and gives workers more autonomy in the workplace (Lorenz and Lundvall, 2010; Lam, 2000; Lam and Lambermont-Ford, 2010). It is widely considered as a practice to improve the innovation capability of the company (Nonaka and Takeuchi, 1995; Lam, 2000; Doeringer *et al.*, 2003; Lorenz and Wilkinson, 2003; Armstrong, 2006; Lam and Lambermont-Ford, 2010; Lorenz and Lundvall, 2010).

However, a high involvement of employees and power endowment to them does not mean employees could disregard a company's overall plan in their technology development. Delegating power to employees without an appropriate level of management control would result in disorder of the firm's operation. Doeringer *et al.* (2003) argue that high levels of delegation decrease the efficiency of the firm because employees' decisions can disrupt the normal production process. This argument has two implications.

First, employee involvement and power delegation are essential to improve employees' engagement in innovation activities. It is the goal of BUL to promote knowledge creation and interactive learning on the shop floor.

Second, management control over BUL is necessary. Similar to the argument made by Doeringer *et al.* (2003) and Wei *et al.* (2011) argue that BUL has a reverted U shape influence on the firm's innovation performance. Having some BUL increases the firm's innovation performance, but having too much BUL will have the opposite effect.

Therefore, it is reasonable to propose that an appropriate level of management control over BUL activities is needed to develop a firm's innovation capability using this approach.

2.3.1.5 Bottom-up learning in Operations Management

Japanese Kaizen (also known as continuous improvement in Western literature) is a very popular topic in operations management in the 1990s (Bessant *et al.*, 1994). It is a very important management tool in Toyota Production System (TPS) (Ohno, 1988) as it is dedicated to involving all members of a company to make continuous changes to production processes and the working environment in order to reduce production costs, to improve production efficiency, to increase the quality of its products (Imai, 1986) and ultimately to learn from daily failures in order to develop innovation (Kajiwara, 2002; Aoki, 2008). In addition, because correcting past mistakes involves searching for solutions through testing new possibilities (March, 1991), learning from past failures aims to improve existing processes or products is the spirit of Kaizen when pursuing innovation (Aoki, 2008).

As mentioned previously, Kaizen activities involve all members of the company to make an effort concerning continuous improvement (Imai, 1986; Bessant *et al.*, 1994). It includes senior managers making front-line operators develop solutions to improve production efficiency or to eliminate waste through enforcing discipline, which is a top-down fashion of management in nature (Bessant *et al.*, 1994). It also includes bottom-up activities, which when initiated by operators, by reporting possible improvements to their superiors, for example, the re-designing of tools or adjusting machines, which may lead to changes if agreed by managers. It has been pointed out that top-down style Kaizen activities serve as guidelines to make sure improvement solutions align with company goals, whilst bottom-up self-reporting improvement opportunities by operators are the main source of new improvement possibilities (Aoki, 2008). Therefore, well-developed

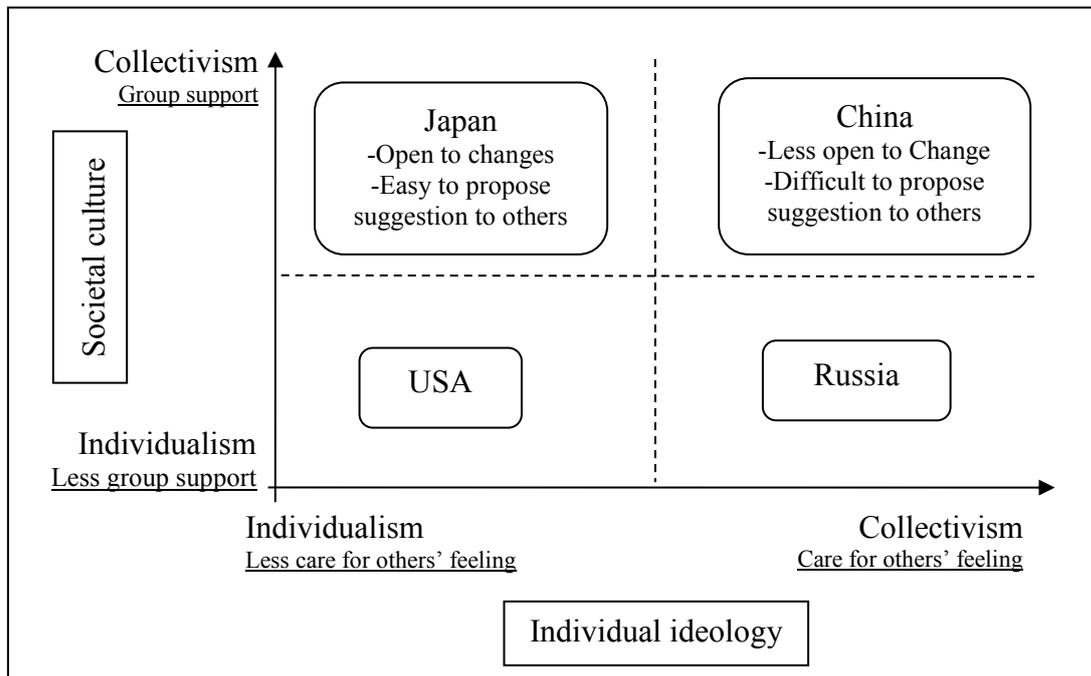
Kaizen procedures should include a balanced top-down and bottom-up fashion of problem-solving (*ibid*).

However, a strong contextual limitation has been noticed when Western companies are trying to copy Kaizen practices from successful Japanese companies to integrate with their own management systems (Bateman and David, 2002; Bessant *et al.*, 1994; Doeringer *et al.*, 2003). This problem not only appears in countries that have great cultural differences like the UK and the US, but also exists in countries that have a similar culture, historically, like China.

China and Japan are often placed into the Eastern countries group for having distinctive culture to the Western countries group represented by European countries and the United States (Pakdil and Leonard, 2017; Begley and Tan, 2001; Ronen and Shenkar, 1985). However, countries within each group also have distinctive cultures from each other (Triandis *et al.*, 1990). According to a study by Ralston *et al.* (1997), China and Japan are only similar at the societal culture level as both being collectivist countries, but significantly different at the individual ideological level where the Japanese are individualist and the Chinese are collectivist.

The distinction between individualist and collectivist cultures is widely used by scholars in cultural studies, for example, Hofstede (1984) and Triandis *et al.* (1988). An individualist culture is reflected by a high degree of self-reliance at the societal level, and less concern for others at the individual level, whilst a collectivist culture is represented by a high level of group support at the society level, and concern for others at the individual level (Ralston *et al.*, 1997).

Illustration 2-2: Comparison of cultures of Japan, China, USA and Russia



Source: Adapted from Ronen and Shenkar (1985)

Ralston *et al.* (1997) point out that because the Japanese are individualistic at the individual level, they can easily propose critical suggestions to superiors without worrying that such activities could lead other co-workers to feel that they are being criticised or penalised. Moreover, because the Japanese have less concern for others' feelings, they are also more open to change (*ibid*). People with an individualistic culture are more open to change because they are encouraged to pursue their own interest regardless of the cost of such activity to others (Schwartz, 1992). This is a crucial reason as to why Japanese firms have been successful in implementing Kaizen practices. The Japanese are more open to change, and are not afraid of proposing suggestions to make such changes (Aoki, 2008).

On the contrary, the Chinese are collectivistic at the individual level so they are reluctant to propose suggestions to superiors to avoid hurting the feelings of co-workers, and are

also unwilling to change existing work (Ralston *et al.*, 1997; Aoki, 2008). Therefore, although China and Japan have a similar culture at the societal level, some Japanese firms find it very difficult to implement Kaizen practices successfully in their subsidiaries in China (Aoki, 2008).

A case study research by Aoki (2008) on how Japanese parent companies transfer their Kaizen practices in China points out that most of those Chinese subsidiaries only involve members from the management level into Kaizen activities, instead of involving all members. Thus, Kaizen in China is conducted only in a top-down fashion. This is because the Chinese front-line operators, in general, do not have initiatives in place to report improvement possibilities to their superior manager, unless a significant amount of management effort associated with motivating, rewarding and disciplining measures are employed (Aoki, 2008).

Therefore, from previously discussed Kaizen studies, it is evident that the top-down style of management is relatively easy to copy across contexts. However, having bottom-up Kaizen initiatives amongst operators is the key to successful Kaizen procedures, which is the key to Toyota's success in its TPS (Aoki, 2008).

It is reasonable to doubt that Chinese firms have adopted BUL strategies, given that it is so difficult to promote Chinese employees to actively participate in bottom-up learning activities based on the case study by Aoki (2008) in China.

2.3.1.6 Define Bottom-up learning in this research

Following empirical investigations in this research, the concept of BUL is defined.

Table 2-2: Summary of definitions of BUL in literature

Author/s	Year	Terms of BUL	Definition of Term
March	1991	Exploitive innovation	Develop innovation using internal resources and knowledge base.
Bessant and Caffyn	1997	High involvement innovation	Innovation developed from continuous improvement activities with the involvement of all employees.
Mom <i>et al.</i>	2006	Bottom-up knowledge inflow	Use suggestions from employees to identify innovation opportunities to develop product and process innovation.
Anderson	2008	Bottom-up perspective on innovation	Develop innovation by recombining existing resources, knowledge, and capabilities within the firm.
Høyrup	2010	Employee-driven innovation	Incremental and radical innovations developed by employees at work through the DUI mode of innovation.
Wei <i>et al.</i>	2011	Bottom-up learning	Information gathered from shop floor employees for managers to identify innovation opportunities.
Lee and Walsh	2016	Non-R&D learning	Innovation based on the knowledge develop at work through problem-solving

As can be seen from

Table 2-2, BUL has been defined in various ways. By summarising the literature, the concept of “bottom-up learning” (BUL) in this paper is defined as:

Definition of Bottom-up Learning:

Knowledge creation, learning and sharing activities by shop floor employees to produce creative solutions to problems, or to develop process and product innovation.

2.3.2 BUL practices

Because the concept of BUL is a recent notion, it has yet to be operationalised by academics. Therefore, this research tries to identify BUL practice from relevant KM, OL, HRM and OM literature.

2.3.2.1 BUL practices in Knowledge Management

A review of the strategy and KM literature underpins the importance of having BUL in firms to develop innovation capability. Reviews on the KM literature further suggest that BUL relies on creating, learning and sharing tacit knowledge within the workforce.

Based on Hoegl and Schulze (2005), several KM practices could be identified that promote BUL.

The first KM practice (ibid) is the *informal event*. This method is meant to encourage informal conversation and build personal relationships amongst employees to facilitate tacit knowledge transfer during or after the event (ibid). It is pointed out that personal and informal conversation is an effective way to facilitate active tacit knowledge transfer (Leonard and Sensiper, 1998). An example of a successful case using this practice is Phonak, a world leading hearing instruments manufacturer, who organises various companies to attend a paid group event, like a day trip, to encourage employees to get to know each other and to build a strong personal network for knowledge sharing at a later stage (Hoegl and Schulze, 2005). A personal network is an essential knowledge base of “know-how” – i.e. personal connections with people who have the expertise (Jensen *et al.*, 2007), which is crucial for knowledge seekers (i.e. shop level workers who have initiatives to modify the current product design) to find the right person with the right skill. A good personal relationship amongst employees will also increase the possibility of the skilled workers’ willingness to share their knowledge with others. This type of knowledge sharing culture based on a personal network would be an ideal environment to foster bottom-up learning for innovation. However, this practice requires a huge amount of time and resource to be invested on socialising activities between workers.

Therefore, firms may not organise such events very frequently, which could be complemented by using the second KM practice.

The second KM practice is *expert mapping*. This KM practice produces a database that serves as a “yellow pages” to allow knowledge seekers to search for the people with the desired expertise (Hoegl and Schulze, 2005; Armstrong, 2006) in order to build contact with them to ask for help with solving problems in their daily work, or for realising certain new ideas about current product improvement. This method shares the same advantage of an informal event approach, which provides a know-how network without organising a lot of social events. However, in the absence of “good personal” relationships among employees from informal events, exporters might be reluctant to share knowledge with a knowledge seeker due to a lack of a personal relationship, or in other words, shared values or culture. Consequently, knowledge might not flow smoothly between shop floor workers even if there are people who have the initiative to contribute to innovation. Therefore, a shared value, or a knowledge sharing environment, is essential for promoting BUL.

The third KM practice is the *record keeping on problem-solving activities at work*. It is an important practice for employees to reflect on their tacit knowledge created at work explicitly to allow others learn from them (Nonaka *et al.*, 2000).

2.3.2.2 BUL practices in Organisational learning

Based on works by Lam (2002, Lam, 2005; Lam, and Lambermont-Ford, 2010) and her colleagues, the J-form organisation is the most suitable form of organisation that promotes BUL. BUL relies on employees’ knowledge, which is mainly in the form of tacit knowledge (Bessant *et al.*, 1994). However, tacit knowledge is very difficult to transfer into explicit knowledge. J-form organisations transfer individual tacit knowledge

into collective tacit knowledge by letting workers solve problems in multi-disciplinary teams to develop shared norms amongst workers. Then those workers rotate to other groups to allow other parts of the organisation to learn from them, and enables them to learn from the new teams as well.

Therefore, two key BUL practices could be identified from these groups. First, the multi-disciplinary team for problem-solving. This practice has been widely proposed by scholars as the key for employees to develop creative solutions to problems that lead to innovation (e.g. Bolton, 1993; Bessant *et al.*, 1994; Nonaka and Takeuchi, 1995; Doeringer *et al.*, 2003; Aoki, 2008). Second, the job rotation of employees. This practice is also widely recognised for improving employees' knowledge and skill sets (e.g. Coşgel and Miceli, 1999; Lorenz and Wilkinson, 2003; Arundel *et al.*, 2007; Preenen *et al.*, 2017).

2.3.2.3 BUL practices in Human Resource Management

Empirical study by Shipton *et al.* (2006) show that the innovation capability of firms could be reflected from within their HRM practices, including 1) *training given to employees* on both work-related and non-work-related topics, 2) *appraisal systems that promote knowledge sharing with co-workers*, and 3) a *contingent reward system* that is based on employees' contributions in terms of creative ideas rather than volume of output. It is argued that these four HRM practices are crucial for firms to develop an innovation capability (ibid).

Internal training is of particular interest for BUL because it relies on employees' personal knowledge to give workshops to colleagues. It is widely recognised as an important practice for developing a firm's innovation capability (Lau and Ngo, 2004; Shipton *et al.*, 2006; Sung and Choi, 2014; Caloghirou *et al.*, 2018; Dostie, 2018). In internal training programmes, firms ask employees with certain expertise to organise workshops for their

colleagues. It facilitates sharing of tacit knowledge because it asks employees to articulate their tacit knowledge into teaching materials so that others could learn from these at internal workshops.

2.3.2.4 BUL practices in operation management

As already discussed in detail in Section 2.3.1.5, Kaizen is an important approach for firms to develop continuous, incremental innovation in their production processes and product designs based on suggestions from employees (Bateman and David, 2002; Bessant *et al.*, 1994; Doeringer *et al.*, 2003).

Kaizen relies on suggestions proposed by employees for making changes to production processes and product design. Therefore, a key BUL practice being identified from Kaizen is the *proposal system* where employees make suggestions on production processes and product design (Bessant *et al.*, 1994). This practice is widely recognised as crucial for developing a firm's innovation capability by relying on the knowledge base of its employees (Bessant and Caffyn, 1997; Aoki, 2008; Aoki *et al.*, 2014; Lasrado *et al.*, 2015; Laviolette *et al.*, 2016; Lasrado *et al.*, 2017).

A summary of a list of BUL practices is produced and presented in Section 2.5.4 on page 105. This list of BUL practices will be used to identify the BUL practices that have been adopted by China's firms studied in this research.

2.3.3 Why Bottom-up learning helps technological innovation

As discussed in Section 2.2.1, a company's internal and personal knowledge constitutes nearly 60% of its knowledge input in successful innovations (Patel and Pavitt, 1994; Dosi, 1988b; Nelson, 2004). It is reasonable to believe that that company will have a greater likelihood of developing successful technological innovation by making proper use of

internal and personal knowledge. From the discussions concerning the bottom-up learning (BUL) literature in previous sections, BUL is a viable method for this task.

BUL helps firms develop technological innovation in three main ways:

- 1) It improves the efficiency and effectiveness of problem-solving activities. As an important source for BUL, employee education and training, and work experience provide initial guidance on how to conduct experiments and knowing what to adjust at various stages according to the results at different stages (Patel and Pavitt, 1997; Pavitt, 1998). The more knowledge they have, the higher the chance they will produce a positive experiment outcome, such as successful innovation.
- 2) It generates practical solutions to problems from trial and error. Nelson (2004) argued that scientific knowledge is useful in mapping out the general direction of viable solutions to the problem but cannot help with finding actual solutions to particular problems. Thus, it is important to use internal and personal knowledge to work out practical solutions to problems on a daily basis, whilst having general technological trends in mind.
- 3) It is complementary to top-down R&D as a new route to carry out innovation. BUL not only motivates employees through a high level of participation and involvement in proposing ideas but also allows managers to have an overall control of the company's technology development through idea evaluation and appraisal systems (Berman and Kim, 2010). Therefore, the company could open up a new route of innovation with BUL without disrupting its mainstream R&D and productions.

Various sectors would rely on different modes of innovation because each sector has a commonly shared technological regime, which defines the direction of technological advancement (Dosi, 1982). Therefore, high-tech sectors, such as the pharmaceutical sector, relies more on the STI mode of innovation (O'Sullivan, 2000; Tylecote and Ramirez, 2006) so BUL may not be important for them. In the mid-high-tech sectors, like

the automobile sector, the DUI mode of innovation is crucial (O’Sullivan, 2000). Therefore, it is reasonable to propose that BUL is important to mid-high-tech sectors.

This study has a particular interest in the mid-high-tech sector because it is relatively R&D intensive. For example, in the automobile sector, radical innovation in engine technology requires mainly formal R&D activities in labs using the STI mode of innovation. However, the automobile sector also relies heavily on incremental innovations in the production process and product designs to lower production costs and to improve product quality (O’Sullivan, 2000).

Therefore, the mid-high-tech sector needs a balance between the STI mode of innovation through formal R&D, and the DUI mode of innovation.

This characteristic makes the mid-high-tech sector particularly valuable for this research because it would be difficult to study the BUL in high-tech sectors because they rely more on formal R&D. Thus, this research specifically studies how the BUL works in the mid-high-tech sector.

2.3.4 Remarks on BUL literature

This section reviewed the BUL literature in five disciplines in an effort to develop a better understanding of BUL and proposes a definition of BUL for this research. Based on the literature reviewed, the concept of “bottom-up learning (BUL)” proposed in this paper is defined in Section 2.3.1.6 as: knowledge creation, learning and sharing activities by shop floor employees to produce creative solutions to problems, or to develop processes and product innovations.

The first area of BUL literature comes from a strategic management leading by the ambidextrous organisation theory that was developed by Tushman and O’Reilly (1996),

which underpins the important role of BUL in developing a firm's exploitive (incremental) innovations. However, this BUL literature is mainly concerned with firms' innovation strategies by proposing that firms need to master developing both exploratory innovation and exploitation innovation. However, it does not provide many insights on why and how successful firms developed such ambidexterity, what management practices help firms to develop both types of innovations, and how. (See Section 2.3.1.1 for discussion). Therefore, BUL literature from knowledge management (KM) and organisational learning (OL) is reviewed.

The second and the third group of BUL literature come from knowledge management and organisational learning fields. They both provide insights on how knowledge is managed and utilised in organisations. Leading works in this area include Lorenz and Lundvall (2010; Lorenz and Lundvall, 2011; Arundel *et al.*, 2007) on measuring creativeness of European countries, and Lam's work on studying knowledge sharing and organisational learning in Japanese firms (Lam, 2000; Lam, 2005; Lam and Lambermont-Ford, 2010). These two groups of literature propose that innovations are developed through collective learning and problem-solving activities at work. Also, they stress the crucial role played by multidisciplinary problem-solving teams in developing knowledge and disseminating personal knowledge across the organisation.

The fourth group of BUL literature centres around human resource management (HRM) studies. This group of literature proposes that employee involvement in innovation process (Doeringer *et al.*, 2003; Lorenz and Wilkinson, 2003; Armstrong, 2006) and delegation of power to employees (Lorenz and Lundvall, 2010; Lam, 2000; Lam and Lambermont-Ford, 2010) contributes to the innovation performance of firms. However, too much power delegation to employees leads to inefficiency in the firm's operation

because excessive employees' ideas disturb the original plan of the firm, Doeringer *et al.*, (2003). Therefore, an appropriate level of management control over BUL is needed.

The fifth group of literature comes from an operational management (OM) background. Kaizen is discussed because it involves a great deal of employee initiative to report possible improvement opportunities to their superior managers (Ohno, 1988; Bessant *et al.*, 1994). It argues that having BUL initiatives is pivotal when having a Kaizen situation but developing such initiative is a challenging task for firms (Aoki, 2008). It implies that the BUL practice could not work in firms when employees do not want to participate in BUL for a variety of reasons. For example, lack of rewards, fear of being penalised by the supervisor, and so on. This problem would render BUL practices to only exist on paper.

Therefore, it is important to evaluate the level of embeddedness of BUL practices during data analysis to distinguish between embedded and not embedded BUL practices in firms.

Because the concept of BUL has only recently developed, it has not been operationalised yet. Therefore, this section identifies nine BUL practice from the available literature. The nine BUL practices are summarised later in Table 2-8. The level of embeddedness of BUL practices will be studied in firms in this research to investigate what BUL practice firms have and how and whether the BUL practice is embedded.

In this research, an embedded BUL practice means that the practice is effective and thus helps the firm facilitate BUL activities. Not embedded BUL practices are not effective in facilitating BUL activities, so they only exist on paper.

Lastly, based on the literature it is found that it is valuable to study BUL in mid-high-tech sectors because they rely on both STI mode and DUI modes of innovation. Thus, they

need a balance between formal R&D and BUL and rely on both ways of learning and problem-solving.

Therefore, this research will focus on studying the BUL practices adopted by firms in mid-high-tech sectors. Moreover, the level of embeddedness of the BUL practices will be evaluated during data analysis.

Reviews of BUL literature develops the first research question:

Research question 1:

“Do China’s firms have bottom-up learning (BUL) practices to develop their innovation capability, and how embedded are BUL practices?”

2.4 National System of Innovation and Developing Countries

The national system of innovation (NSI) is widely regarded as an approach focusing on analysing innovative actors and the interactions among them that are shaped by institutions within national boundaries (Freeman, 1987; Lundvall, 1992; Nelson and Rosenberg, 1993; Edquist and Lundvall, 1993; Niosi *et al.*, 1993). This approach explains how national institutions foster the “national technological capability” (Lall, 2000: 14). In addition, the NSI approach explains why certain sectors could achieve a better performance in one country than in others, by pointing out that different national institutions form different market conditions that favour different types of technologies, which encourage the development of different industries (Malerba, 2002; Chaminade *et al.*, 2009).

Among the different ways that scholars use NSI approach in their work, two major routes could be identified in the literature, namely a “narrow” and a “broad” perspective of NSI

(Lundvall *et al.*, 2009). The fundamental difference lies in the way innovation is understood by scholars.

The scholar who took the narrow perspective of NSI equals innovation merely to science and technology (S&T) advancement (Lundvall *et al.*, 2009). Therefore, the main focus of their work is on how S&T policies cultivate new to the world technological innovations, the majority of which are radical innovations that have a significant impact on both economic growth and the existing technology base of some industries (Lundvall, 1992; Nelson and Rosenberg, 1993; Edquist and Lundvall, 1993; Niosi *et al.*, 1993). These sorts of radical innovations were mainly developed in developed countries.

Thus, the narrow perspective of NIS approach is applied when studying NSI in developed countries, such as the United States (Nelson, 1993; Niosi *et al.*, 1993; Kim, 1997; Kim and Nelson, 2000).

The scholars taking the broad perspective of NSI not only recognise the importance of radical innovations in economic growth, but also include diffusion and the improvement of existing technologies in the innovation process (Freeman, 1987, 1988; Lall, 2000; Viotti, 2002; Lundvall *et al.*, 2009). The broad perspective of NSI becomes critical when studying NSI in developing countries that mainly have a low innovation capability (Lundvall *et al.*, 2009). Most innovation efforts in developing countries are still limited to imitation and to making improvement to those technologies developed in developed countries (Viotti, 2002).

Therefore, as already discussed in Section 2.2.3.1, the innovation in the broad perspective also includes incremental innovation that build on existing technologies new to the firm, the industry or the country (Pack and Westphal, 1986; Kim, 1997; Kim and Nelson, 2000).

Given this, to analyse innovative activities in developing countries, the broad definition of the term “innovation” needs to be used, which is fundamentally learning (Viotti, 2002; Lundvall *et al.*, 2009).

Taking China as an example of a developing country that is trying to become an innovative country by 2020, various researchers (e.g.: Lu and Lazonick, 2001; Cai and Tylecote, 2005; Liu and Tylecote, 2009; Xiao *et al.*, 2013) pointed out that China still has a relatively low innovation capability to develop indigenous innovation, and their reliance on foreign technologies is still considerably high, at least in some sectors.

As the focus of this thesis, the China’s NSI will be discussed further in the following subsection.

2.4.1 China’s NSI

Amongst developing countries studied by scholars, most of them study capitalist economies, including Singapore, Taiwan, South Korea, and India. Only a limited number of scholars have focused on understanding the NSI of China, which is a socialist economy that has a different institutional set up from developed, and most of the other developing, countries.

There are two leading scholars who focus on studying China’s NSI, namely Xielin Liu (Liu, 2009; Liu and White, 2001) who studied China’s innovation capability using statistical data, and Lan Xue (Xue, 1997; Xue *et al.*, 2011) who studied China’s NSI through an historical analysis of China’s innovation policies. In addition, some international organisations, including OECD and the World Bank, also produce reports on China’s R&D expenditure and technological development. However, there is one issue with the existing literature on China’s NSI, is that it relies overwhelmingly on using R&D

figures and other quantitative data to represent the level of innovation capability and by comparison with other countries. It makes the incremental innovation unrepresentative in most of the static data because they are difficult to measure and quantify (Pavitt, 1999). Moreover, it has been pointed out that around 40% of innovation activities are outside of formal R&D, especially in mechanical engineering sectors (Patel and Pavitt, 1994). Therefore, the innovation capability of China could not be accurately represented by only calculating formal R&D expenditure, at least not in the mechanical engineering sector.

Moreover, by only looking at statistical analyses of China's NSI with R&D figures, education statistics, number of patents, and so on, it is difficult to understand how institutions influence innovation activities at firm level. As mentioned above, the NSI approach studies innovation actors in a country and interaction amongst actors (Freeman, 1987; Nelson and Rosenberg, 1993; Edquist and Lundvall, 1993; Lundvall, 2010). Without in-depth investigation of innovation activities by the innovation actor like a firm, it is difficult to understand the impact of China's NSI on innovation activities of innovation actors.

Therefore, this research aims to develop the understanding of China's NSI by studying the impact of institutions on a firm's innovation activities.

2.4.1.1 Role of the state in China's NSI

China is a distinctively interesting case because government intervention in the economy plays a more significant role in China than in other countries (Liu, 2009; Liu and White, 2001).

Historical cases suggest that government intervention in the market has been a widely used approach by developing countries to boost and control economic growth. For

instance, the government of South Korea, Taiwan and Singapore have played important roles since the early stages of their economic reforms to establish market infrastructures, increase educational standards, create protective policies for domestic industries and encourage exports (Lall, 2000).

However, the Chinese government controls the economy in different ways compared to the previously mentioned developing countries. Instead of solely developing market infrastructures and investing in education, the Chinese government has directly established many state-owned enterprises (SOEs) in nearly all industries, and manages them through central planning during the planned economy era before the late 1980s (Xue, 1997; Liu and White, 2001; Motohashi and Yun, 2007; Liu, 2009). Examples of central plans include the five-year plans, industrial strategies, quotas for production and so on.

Although China has transformed itself to a more market economy since the late 1980s, the central and local governments are still strongly intervening in the economy because they still own a high number of large companies in mid-tech, mid-high-tech and high-tech industries (Boeing and Sandner, 2011). It has been argued that the powerful role of the government is useful when concentrating limited resources to quickly catch-up with the development of certain technologies (Fagerberg and Godinho, 2005; Liu, 2009) because a liberated market cannot effectively promote the development of new technology due to unpredictable returns and the high risk of R&D investment (Lall, 2000). Therefore, the establishment of SOEs in many sectors, and the centrally-made plans by the government have helped the Chinese economy to proliferate to some extent.

Nonetheless, because the state both owns and manages a large number of enterprises, China is criticised by OECD (2008; Liu, 2009) that Chinese companies do not have

“bottom-up” initiatives in innovation. This argument could be interpreted at two levels. First, at the national level, because China’s economy is largely controlled by large SOEs whose R&D is guided by industrial plans, SOEs do not have sufficient autonomy to respond to the market, thus are unable to develop innovation with bottom-up initiatives. Second, at the firm level, because the government manages those SOEs in a top-down fashion, the way how top managers of SOEs manage innovation activities inside firms is likely to be in a top-down fashion as well. Therefore, innovation activities in SOEs are likely to be planned by top managers, while innovative ideas and suggestions proposed by people at the lower levels of the organisation are often neglected. Therefore, the bottom-up initiative in innovation amongst employees is likely to be low in China’s SOEs.

Since the Chinese economy is still state-owned and centrally managed (Boeing and Sandner, 2011), the decision about what to develop within a state-owned company is made in a top-down format by top managers, in response to government plans. This type of management style is similar to the machine bureaucratic form discussed in previous sections and there being a lack of autonomy in the working units (Shleifer, 1998; Lam, 2000). Therefore, at the national level, the innovation direction of China is set by policymakers and executed by top managers in SOEs. At the firm level, the direction of innovation is decided by top managers of SOEs without involving employees in any decision-making processes. Thus, the bottom-up initiative in innovation is likely to be low at both levels.

To sum up, China is still a “state-owned and centrally planned” country to some extent, where the government is still playing a strong role in the market in a “top-down” instructive fashion. In addition, it has been argued that old fashioned “top-down” decision-making still strongly influences how SOEs operate today despite all the reforms

at different stages of the Chinese economy's development, particularly in terms of government protection on SOEs from competition, and the provision of easy financial capital to SOEs (Yam *et al.*, 2004).

From the discussion above, it is found that SOEs play critical roles in China's NSI. Thus, SOEs in China will be further discussed in the next sub-section to develop a better understanding on how SOEs innovate under China's NSI.

2.4.1.2 SOEs in China

State-owned enterprises (SOEs) in China dominate most of important sectors which the Chinese government have classified into two main groups, namely "Strategic and Key Industries" and "Basic and Pillar Industries" (Liu and Tylecote, 2016: 343) that are all considered as critical to Chinese market stability, economic growth and/or national security (Mattlin, 2009). Therefore, state ownership has been used as a tool to increase government control over them even though the percentage of government share is reducing in some sectors (*ibid.*).

At its initial stage, the technology development of China overwhelmingly relied on help from the Union of Soviet Socialist Republics (USSR) in the form of direct technology transfer, building turnkey factories in China (e.g. First Automobile Works), sending Chinese engineers to USSR for training, and sending scientists from the USSR directly to China (Xie and White, 2006; Liu and White, 2001). This helped China significantly in developing the foundation of its technological capability. However, from the late 1950s to the early 1960s, the relationship between China and USSR quickly took a downward turn, and all help from the USSR immediately withdrawn in 1960 (Quested, 1984). This incident taught China an important lesson on the dangers of relying solely on foreign counterparts to develop her technologies. Thus, the Chinese central government

announced a new S&T strategy emphasising “self-reliance” for its technological development (Zagoria , 1962: 320). This strategy has had a profound influence on the routine of Chinese S&T development which still has some influence on the innovation activities of Chinese SOEs and universities today. It could partially explain why China tends to domestically develop and produce almost everything, often regardless of whether or not it can be purchased from abroad.

After the Chinese central government launched its open-door policy in the 1980s, the number of SOEs in China has decreased dramatically through privatisation (Liu and Lundin, 2007). Moreover, the decision-making power has been delegated by central government to top managers of SOEs through two responsibility mechanisms, namely the “enterprise responsibility system” – delegating some of the decision-making power from the government to SOEs, and “director (or manager) responsibility system” – allowing SOEs to operate independently from government intervention between 1985-1988 (Child and Lu, 1990: 321). After several rounds of SOEs reforms, the remaining SOEs are mainly concentrated in two groups of strategic industries nowadays (Liu and Lundin, 2007).

For “Strategic and Key Industries”, most of the SOEs are owned by the central government directly in sectors like energy, defence, aerospace, railway, telecommunication service, and so on. Those sectors mainly represent a high entry barrier in terms of fixed costs along with a difficulty to generate profits in the short-term. On one hand, this group of SOEs faces intensified intervention from the central government. On the other hand, they receive a tremendous amount of domestic protection, technological support and easy financial capital (Liu and Lundin, 2007).

The numbers of SOEs in those protected sectors are usually very small so that SOEs do not compete with each other (Liu and Tylecote, 2016). For example, there are only four SOEs in the telecommunication service sector, only three SOEs in the fuel sector, only two SOEs in the electricity generation business, only one giant SOE group in railway (train) production and only two large SOE groups in the defence sector.

However, it is pointed out that private firms in China are still weak in innovation (Liu, 2009). Therefore, amongst the best-performing companies in certain sectors, most of them are SOEs. Consequently, SOEs still dominate those sectors even though there are more private and FDI companies than SOEs.

Table 2-3: Number of firms in Automobile, Railway, Shipbuilding, Aviation and Aerospace equipment production, by ownership type, 2012-2015

Automobile production	2015	2014	2013	2012
Number of SOEs	741	699	688	665
Number of private firms	7114	6767	6224	5414
Number of FDI (include Hong Kong and Macau)	2953	2864	2721	2586
Total	10808	10330	9633	8665
Railway, Shipbuilding, Aviation and Aerospace equipment production				
Railway, Shipbuilding, Aviation and Aerospace equipment production	2015	2014	2013	2012
Number of SOEs	519	505	507	493
Number of private firms	2690	2665	2642	2511
Number of FDI (include Hong Kong and Macau)	679	697	730	738
Total	3888	3867	3879	3742

Source: Adapted from China National Statistic Bureau (2017).

Taking the automobile, railway, shipbuilding, and aviation and aerospace equipment sectors from “Strategic and Key Industries” and “Basic and Pillar Industries” as examples (see Table 2-3) the number of private firms and FDI are significantly higher than the number of SOEs in this sector. However, in certain industries, the best performing enterprises in terms of sales are nearly all state-owned.

Table 2-4: Top ten Chinese bestselling automobile brands ranked by sales: Jan to Nov 2016

Ranking	Company Name	Sales (million cars)	Ownership
1	SAIC	22.41	SOE
2	Changan	15.73	SOE
3	DFM	12.23	SOE
4	BAIC	11.7	SOE
5	Great Wall Motors	9.24	Private
6	Geely	6.87	Private
7	Jianghuai Motor	5.81	SOE
8	Cherry	5.53	SOE
9	FAW	4.64	SOE
10	BYD	4.41	Private

Source: Adapted from China Association of Automobile Manufacturers (2016)

Table 2-5: Top ten Chinese bestselling commercial vehicle manufacturers ranked by sales: Jan to Nov 2016

Ranking	Company Name	Sales (million car)	Ownership
1	BAIC	4.37	SOE
2	DFM	4.29	SOE
3	Changan	3.36	SOE
4	SAIC	3.00	SOE
5	Jianghuai Motor	2.51	SOE
6	FAW	2.15	SOE
7	CHNHTC	1.79	SOE
8	Lifan	1.41	Private
9	Brilliance Auto	1.17	SOE
10	Shannxi Auto	0.99	SOE

Source: Adapted from China Association of Automobile Manufacturers (2016)

Taking the Chinese automobile industry as an example of “Basic and Pillar Industries”, only three out of the top ten best-performing companies in terms of sales are private (see Table 2-4). If narrowed down to the commercial vehicle sector, which the Chinese government did not allow much FDI came in initially in huge contrast with the passenger car sector, only one out of the ten best-performing companies is private (see Table 2-5). Therefore, it is reasonable to conclude that in certain sectors among “Strategic and Key

Industries” and “Basic and Pillar Industries”, SOEs holds most of the market share and so dominate those industries, at least in the Chinese automobile industry.

In addition, the previous literature shows that the corporate governance (CG) of firms in China have a significant influence on firms’ innovation performance since SOEs are well protected and financed by the government. Therefore, the literature on studying the relationship between CG and the innovation capability of firms will be reviewed in the following sub-subsection.

2.4.2 Corporate governance and innovation capability of firms

Studies that specifically reveal how the corporate governance (CG) of firms improves or hinders their innovation capability development are mainly led by two groups of researchers, who both started focusing on this topic around the late 1990s, but addressed the topic from different angles.

The first group of literature is led by Tylecote (e.g.: Tylecote and Conesa, 1999; Miozzo and Tylecote, 2001; Tylecote *et al.*, 2002; Cai and Tylecote, 2005; Tylecote and Ramirez, 2006; Tylecote, 2007; Liu and Tylecote, 2016) and his colleagues, who, from their first paper started to specifically focus on explaining how the national corporate governance and financial systems influence the advancement of various technological fields in 1999. They addressed the relationship between CG and innovation by identifying four different challenges that the national “Corporate Governance and Financial system (CG&Fs)” (Tylecote and Ramirez, 2006: 160) need to overcome before technological innovation can be developed in certain technological fields. Four challenges have been identified including (1) visibility of innovation activity and returns from a manager’s point of view; (2) novelty of innovation which questions either industry-specific knowledge or firm-specific knowledge is more important in developing certain innovation, as high novelty

innovation requires more industry-specific knowledge (Tylecote and Ramirez, 2006) ; (3) appropriability of innovation, defines how easily firms could protect their innovation, and to what extent stakeholder inclusion is needed over shareholder priority (Tylecote *et al.*, 1998); (4) and reconfiguration needs of the innovation determines whether radical change in the organisation is needed to embrace new technology (Tylecote and Ramirez, 2005).

The second group of literature is led by Lazonick and O'Sullivan (1996; O'Sullivan, 2000) who addressed the relationship between CG and innovation by identifying three types of conditions that CG of the firm needs to fulfil before developing innovation. Three conditions including (1) "financial commitment", which means innovation requires long-term, continuous and patient investment; (2) "organisational integration" which means the firm needs to have an inclusive collective learning system that involves both managerial and non-managerial employees; (3) "insider-control" which suggests that technological innovation requires the owner of firms to have a sufficient level of expertise in that sector, and preferably also has firm-specific expertise so that they are capable of evaluating and choosing amongst viable possibilities of technological development (O'Sullivan, 2000: 39).

Both groups of literature will be discussed in the following two subsections.

2.4.2.1 Challenges to CG for innovation

As discussed in Section 2.2.3, innovation has four characteristics. First, novelty, innovation contains a certain degree of novelty for the world, country, sector or firm. Second, cumulateness (path-dependent), new innovations are usually final products of cumulative, incremental innovations throughout years or even decades of development. Third, systemic, as innovation is usually developed within a larger system of interrelated technologies, and innovation will influence the present configuration of technology

regime to a different extent based on its novelty. Fourth, uncertainty, where the process of innovation development involves a risk of failure, and successful innovation may not outperform what rivals have already developed so that it is unable to generate returns.

Each of these characteristics poses a significant challenge to the national level “Corporate Governance and Financial system (CG&Fs)” (Tylecote and Ramirez, 2006: 160) if the development of a certain technological field is desired, as current CG&Fs might be unable to cope with the challenges so fails to improve the innovation capability in the desired technological field. Because each sector has its technological basis, CG&Fs that fail to address challenges posed by innovation in certain technological fields would consequently cause a negative impact on the performance of relevant sectors.

Tylecote (Tylecote and Conesa, 1999; Tylecote and Ramirez, 2006) and his colleagues identify four types of challenge posed by innovation that CG needs to address before firms can develop successful technological innovations. The four challenges posed by innovation include:

First, the *visibility* of innovation activities. Top managers need to be able to appreciate innovation activities that are difficult for them to recognise at a distance, especially when top managers are “outsiders” who lack the industrial and firm-specific knowledge to know how technologies and other systems work in the firm (Tylecote and Ramirez, 2008). This requires that CG&Fs pose less “short-term-pressure (STP)” on top managers to allow the top managers to be patient with slow returns from investment in innovation projects (Demirag and Tylecote, 1992:7). This also requires top managers to engage in daily operations of firms to understand why certain slow, and less visible innovation efforts, are necessary for developing technological innovations in their sector (Tylecote and

Visintin, 2008). In addition, it is preferred that top managers have firm-specific knowledge as this helps them to understand better the process of low visible innovation activities (Tylecote and Ramirez, 2008).

The requirement for managers to understand low visibility innovation activities varies considerably across sectors due to the difference in the technological base of sectors. It is suggested that the amount of invisible expenditures and efforts invested in innovation projects are very high in engineering sectors, whilst low in the pharmaceutical sector (Tylecote and Hirata, 1993; Tylecote and Ramirez, 2006).

The visibility of innovation is highly relevant to this research. Because this research specifically studies low visibility BUL activities in the engineering sector, top managers in firms need to have a high level of firm-specific knowledge so that they can understand and appreciate low visibility innovation activities.

Second, the *novelty* of the innovation to the firm. Developing or adapting radical innovations that are far from a firm's present technology base requires managers to have industry-specific experts, so that they have a wider spectrum of valid choices of planning or strategy for future development (Tylecote and Conesa, 1999; Tylecote and Ramirez, 2006).

Although addressing the novelty of innovation is critical to developing innovation, this element of the CG&Fs model is less relevant in the context of this research. It is because the expected outcomes of BUL are incremental product and process innovations. Thus, managers do not have to have a high level of industrial-specific knowledge to adopt the BUL approach to develop innovation capability of firms.

Third, *appropriability* of innovation reflected in terms of whether a firm adapts a shareholder first or stakeholder first approach (Tylecote and Conesa, 1999). Shareholder first approach is suitable when developing technologies that are easily protected from spill over, the pharmaceutical sector for instance, where innovation outcomes can be easily articulated and protected with patents. A stakeholder first approach facilitates the development of technology that is hard to protect from imitation and spill over. For instance, it is difficult to protect an intricate mechanical engineering design and a worker's tricks since they are based on the tacit knowledge possessed by individual workers. Such knowledge could easily be acquired by rivals if the key employees have been poached. In this situation, a stakeholder first approach is usually preferred to provide employees with a higher level of job security and appropriate welfare.

The appropriability of innovation is particularly important in the context of this research. It has been pointed out that around 40% of innovation activities are outside the formal R&D functions, especially in the mechanical engineering sector (Patel and Pavitt, 1994). It is because the knowledge base of the engineering sector has a large amount of tacit knowledge embedded across the workforce. Workers develop tacit knowledge as a result of their daily problem-solving experiences at the shop floor (Nelson and Winter, 1982; Bessant and Caffyn, 1997; Jensen *et al.*, 2007). Thus, it is important that engineering firms adopt the stakeholder-first approach to maintain a stable workforce to protect and retain its knowledge for innovation.

Fourth, *reconfiguration* capability when changes in an organisation is required to embrace a radically new technology or to be successful in developing radical innovations (Tylecote and Ramirez, 2006). It is, sometimes, vital for large and old firms who are already successful in certain fields to have such a capability, e.g. by laying-off an obsolete

workforce, introducing a new robotic production line, under pressure from both “competence destroying” technological change - radical change in the technological regime of the sector, threats from rivals who are more flexible to make changes, and from new start-ups who do not yet need to reconfigure anything (Tylecote and Visintin, 2008). Apart from this, reconfiguration capability is also important if firms choose to engage in a new field of technology that is far from its existing knowledge base. It is argued that organisational re-structuring is often required before the new technology can be assimilated (Tylecote and Ramirez, 2006). Radically new technologies could make an existing workforce entirely obsolete. Thus, the ability to renew the workforce becomes critical in sectors where the technological regime frequently shifts, which is usually in high-tech sectors.

Although it is crucial for firms to have reconfiguration capability to embrace and develop radical innovation, this element of the CG&Fs model is less relevant to the context of this research. This is because the focus of this research is on incremental innovations, which is close to the existing knowledge base of firms. Thus, firms do not have to have a high level of reconfiguration capability to adopt BUL approach to develop their innovation capability.

To sum up, based on the arguments made by Tylecote and his colleagues (Tylecote and Conesa, 1999; Tylecote and Ramirez, 2006) technological innovations pose at least four challenges to CG&Fs, *visibility, novelty, appropriability, and reconfiguration*. The settings of national CG&Fs when addressing these four challenges will affect how firms behave in their innovation activities. Thus, the industrial structure varies amongst countries due to the difference in the characteristics of CG&Fs in countries.

2.4.2.2 Conditions CG needs to fulfil needs of innovation

The framework proposed by O'Sullivan (2000; Lazonick and O'Sullivan, 1996) studies the relationship between CG and innovation in engineering sectors from a strategic management point of view. The fundamental nature of innovation is knowledge creation that requires efficient resource allocation into knowledge creation projects (O'Sullivan, 2000).

Managers allocate resources to innovation activities according to their strategies. Their decision-making is significantly influenced by both the internal and external environments to the firm. Whilst the external environment is usually shaped by competition and other institutions, the internal environment is mainly formed by its CG, meaning how firms are owned and controlled (O'Sullivan, 2000). Concerns are mainly twofold. First, any technological innovation, as an outcome of innovation activities of firms, requires an appropriate management structure to enable efficient resource allocation, in terms of what to invest, how resources are processed, and what outcomes are expected (solving problems, or anticipating the product to be developed) (O'Sullivan, 2000). Second, since innovation activities naturally contain an element of risk meaning that the outcome is unknown (Nelson and Winter, 1982; Dosi, 1988), decisions on which technological prospect to pursue is also critical.

With these two concerns in mind, Lazonick and O'Sullivan (1996; O'Sullivan, 2000) identified three conditions that CG needs to fulfil before innovation projects can be accomplished successfully. This model includes:

First, a *financial commitment* to innovation activities, innovation projects require patient funding and a long-term plan to succeed (Pavitt and Patel, 1988). Therefore, it is critical that the CG of a firm provides some committed financial capital.

This condition is important for this research as BUL mainly produces incremental innovations. It is a slow pay-off process which requires long-term and patient investment (Tidd *et al.*, 2005). Thus, it is important that top managers of firms plan for long-term development of their innovation capability by using the BUL approach. The subsequent condition also stresses the importance of long-term planning by top managers.

Second, “*insider*” control of the firm. To have a long term-vision and a dedicated long-term plan for improving their innovation capability, top managers need to have a sufficient level of firm-specific and industry-specific expertise so that they can choose between many viable routes of technological prospects (O’Sullivan, 2000). Also, managers need to be motivated and rewarded in ways that allow them to secure greater gains from such long-term development of the firm because innovation requires patient investment. Otherwise, short-termism gain will have a harmful impact on the development of innovation capability of the firm in the long-run (Pavitt and Patel, 1988).

Insider control of firms is critical to their success because those managers who have a more firm-specific knowledge. In addition, due to their long-term employment in firms, they have a higher stake in the good long-term performance of the firm. Thus, insider managers are more likely to plan for the long-term development of innovation capability and allow for patient investment on such slow-payoff innovation efforts.

Third, *organisational integration*. The reasons here are two-fold. First, because innovation is a social process comprising interactive learnings that create knowledge (Best, 1990; Lazonick, 1990; Lundvall, 2010; Edquist, 1997). It requires active learning amongst workforce, apart from merely following instructions given by managers on what to do. Second, because the knowledge base of the engineering sector is mainly tacit, it is

impossible to share its knowledge without close personal interaction in the knowledge sharing process (Nelson and Winter, 1982; Lazonick, 1990; Nonaka, 1994; Pavitt, 1999; Smith, 2001). Moreover, the knowledge required for changing products and processes is still mostly tacit (Senker, 1995; Senker, 2008).

Moreover, evidence from economic history shows that the higher the level of complexity of technology, the lower the level of workforce need to be involved in the process of the technology development (Bell and Pavitt, 1997). Therefore, in order to develop innovations in sectors that have a complex technological base, a low level of the workforce needs to be involved in any decision-making, and in the formal and informal innovation process.

This condition has particular implications in this research. The core participants in the BUL process are first-line workers who have rich tacit knowledge accumulated from problem solving activities at work (Lam, 2000; Nonaka and Takeuchi, 1995). Therefore, BUL could be an appropriate approach to develop that innovation capability of firms in sectors whose knowledge base has a high number of tacit elements.

2.4.2.3 Remarks on two CG and innovation models

Both avenues of literature address a similar problem, which explores how the corporate governance of firms influences their innovation capability. Two models share some factors even though they are named differently. They also have some differences because those two models have been applied in different contexts. The underlying propositions of the two models are summarised and compared in Table 2.6.

The model by Tylecote and colleagues (e.g. Tylecote and Conesa, 1999; Tylecote and Ramirez, 2006) studies how national level CG&Fs impacts different sectors in one

country, or how one sector, globally, is influenced by national CG&Fs in different countries. An advantage of their works is that they have comparatively studied sectors who have distinctive knowledge base like the automobile sector (Liu and Tylecote, 2009), the equipment manufacturing sector (Xiao *et al.*, 2013) and the pharmaceutical sector (Tylecote and Ramirez, 2006). They also studied different countries like China (Tylecote and Ramirez, 2006; Xiao *et al.*, 2013), the UK and the USA (Tylecote and Ramirez, 2006).

In terms of similarity, the two models share some similar arguments regarding how innovation could be facilitated by suitable corporate governance conditions. First, both models stress the importance of long-term perspective for developing innovation capability and continuous financial investment to support innovation activities. Second, both models propose that top managers should have firm-specific knowledge to understand how technology works, and to choose the direction of innovation. Third, both models argue that it is important to involve workers into the process of innovation.

Comparing to the model by Lazonick and O'Sullivan, Tylecote's model has two distinctive features that are highly relevant to this research. First, it builds macro-micro linkages between national institutions and the development of innovation capability in firms (Cai and Tylecote, 2008; Liu and Tylecote, 2009), by studying the challenges that innovative activities in different sectors pose to the national CG&F system. It also proposes that countries have different national CG&Fs that promote the development of different technological fields (Tylecote, 2007), which consequently explains the national specialisation in different technological fields. Second, Tylecote's model has been widely applied in studies of innovation capability of various sectors in China, which include the automobile sector (Liu and Tylecote, 2009), the equipment manufacturing sector (Xiao

et al., 2013) and the telecommunication sector (Cai and Tylecote, 2008). Therefore, Tylecote’s model has been proven suitable in studying innovation related issues in China.

Table 2-6: Comparison of underlying propositions of the two CG and innovation models

Challenges to CG&Fs (Tylecote)	Underlining proposition	Conditions CG need to fulfil (O’Sullivan)	Underlining proposition
Visibility	Firms need to have a long-term plan and patient financial capital; manager needs to engage to appreciate innovative activities that are difficult to observe at a distance	Financial commitment	Innovation requires long term, continuous and patient financial investment
Novelty	Industry-specific knowledge is needed for technologies with high novelty. Low novelty technology relies more on firm-specific knowledge.	Insider control	Managers of firms need to have sufficient industry-specific and firm-specific knowledge to evaluate and select viable technological possibilities to commit
Reconfiguration	Technology that is far from the existing knowledge base of the firm requires organisational restructuring before the new technology can be assimilated.	Organisation integration	Innovation requires the high involvement of all employees in collective learning. The more complex the technology, the greater degree of involvement of shop-floor worker is needed.
Appropriability	Shareholder-first approach could help with developing technologies that are easy to protect from spill over. Stakeholder-first approach facilitates the development of technology that is hard to protect from imitation and spill over.		

Tylecote’s model will be used as the framework for the corporate governance analysis of firms studied in this thesis because 1) it built macro-micro linkages between national

institutions and the development of innovation capability in firms; and 2) it has been proved suitable for studying innovation related issues in China.

2.4.3 CG and innovation activities in China's firms

Although some challenges in Tylecote's model are not relevant in the context of this research, his work has contributed greatly to studies on China. While, another model by Lazonick and O'Sullivan has not been applied in the Chinese context. Thus, based on Tylecote's work, this sub-section will review the impact of China's CG on innovation activities in Chinese firms.

Tylecote and his colleagues have conducted various case studies studying corporate governance of Chinese firms in the auto sector (Liu and Tylecote, 2009, Tylecote, Cai and Liu, 2010), the telecom sector (Tylecote, Cia and Liu, 2010), the machinery sector and the TV sector (Xiao *et al.*, 2013).

As already discussed earlier in Section 2.4.1, state-ownership of firms is one of the major institutions of China's NSI that have a significant impact on China's economic development. Moreover, SOEs have also been found to be dominating China's mid-tech to high-tech sectors (Boeing and Sandner, 2011). Therefore, this section will review and discuss the work by Tylecote and his colleagues who mainly studied China's SOEs in their case studies.

In addition, this section aims to develop a workable framework for studying how CG, a key part of institutions in China's NSI, influences firms BUL. Therefore, a conceptual construct to study how CG influences firm's BUL will be proposed at the end of this sub-section.

It is found that state ownership of the firm in some sectors in China, and monitoring and management infrastructures of SOEs caused a major flaw in the process to build a technical innovation capability (Tylecote, Cai and Liu, 2010). A key weakness of China's SOEs being identified is the management appointment of top managers to SOEs by the SASAC (State-owned Assets Supervision and Administration Commission) (Liu and Tylecote, 2009, Tylecote *et al.*, 2010; Xiao, Tylecote and Liu, 2013). Because top managers of SOEs were usually officials from government agencies, he/she lacks relevant professional knowledge and the time to monitor the SOE closely (Liu and Tylecote, 2009). In addition, because the director was appointed directly by central SASAC and would be likely to leave in the short-term of around five years, they do not have responsibility for the long-term development of the SOE (Liu and Tylecote, 2016). It is because their career development and personal gains are not linked with the long-term development of the SOE. Thus, they become disengaged with the SOE they are managing and are unlikely to appreciate the innovation activities that are low-visibility to high-level managers (Tylecote and Visintin, 2008).

This causes a major weakness in Chinese SOEs, which is having disengaged top managers (Cai and Tylecote, 2005; Tylecote *et al.*, 2010). Due to the disengagement of managers, they are reluctant to invest in any long-term capability building programmes because these are slow to payoff. At the same time, the management of the firm is very exclusive, which does not involve the participation of low-level worker (*ibid*, Liu and Tylecote, 2009). This problem leads to major losses of knowledge embedded in employees and causes weaknesses in problem-solving and the development of any innovation capability (Tylecote *et al.*, 2010).

In addition, it is pointed out that these conventional large-scale SOEs tend to purchase readymade, fully assembled and packaged technologies and equipment (entire production lines) because they are easy to understand and could have an immediate effect on improving production (Liu and Tylecote, 2009). This is because top managers of those SOEs are appointed for the short-term only, so they need to produce observable results in a short period to please their supervising officials so that they might be placed in a better position after their term in office ends (Tylecote, Cai and Liu, 2010). Developing innovation internally would be costly and time consuming, and could displease supervising officials if the innovation fails. Thus, they choose to buy readymade technologies that are faster in producing good outcomes, and less risky than in-house innovations.

The drawback of using this method to acquire technology is that engineers do not understand the principle of how and why such technology bundles work. Consequently, engineers cannot modify or improve them (Tylecote *et al.*, 2010). It is because using readymade technological bundles means engineers and work do not have the opportunity to fully understand how different machines work as a production system, Therefore, they become incapable of making further independent improvements to the production process. It is because the relevant technological knowledge (knowledge about how things work together) is usually accumulated gradually in the process of developing the technology, and is often tacit and embodied in the employees who were part of the development process (Pavitt, 1999). If firms choose to rely on technology bundles, this knowledge accumulation process is absent.

Conversely, some new (some of them are transformed from old ones at a certain stage) SOEs performed much better than conventional large size SOEs (Liu and Tylecote, 2009).

The reasons for this are two-fold. First, top managers of these new SOEs are usually experts in the underlying technologies before they come to these SOEs. With such a knowledge base, they could understand the cutting-edge technology in the foreign market, and buy equipment separately to construct their production line (Liu and Tylecote, 2009). Thus, their innovation performance is much better than other SOEs because they have acquired knowledge accumulation during the process of constructing their production line.

Secondly, because this type of new SOE is usually a pillar industry in certain small cities, officials of the city government believe them to be the major engines that drive the local economy. Thus, they are given more autonomy to operate independently away from close government intervention in the management (ibid). In addition, these local SOEs are given various privileges and benefits if they perform well; however, much depends on the discretion of the government officials (ibid).

Based on the reviews of this literature, three useful insights could be identified.

First, as an important institution in China's NSI, state-ownership could strongly influence the technical innovation capability in SOEs. In addition, SOEs seems to be managed differently by the government in various regions. For instance, SOEs in small cities are found to be more innovative because the local government grants them autonomy and privileged access to capital (Liu and Tylecote, 2009). This phenomenon has also been noted by Child and Lu (1990) pointing out that after the control of SOEs is passed down to local government, the relationship between the SOEs and the government (local government) becomes 'closer (or intimate)' allowing SOEs to have access to favourable deals or policies.

Second, government appointment of top managers to SOEs has a profound influence on firms' development of innovation capability. It is because the government tends to appoint outsiders as top managers of SOEs (Tylecote, Cai and Liu, 2010) who are disengaged and lack understanding of the firms' technological base. However, SOEs who have appointed insiders as top managers tend to have a higher innovation capability (Liu and Tylecote, 2009). Therefore, this research will include **management appointment of insider or outsider by the government** as a factor to explain the innovation activities in SOEs.

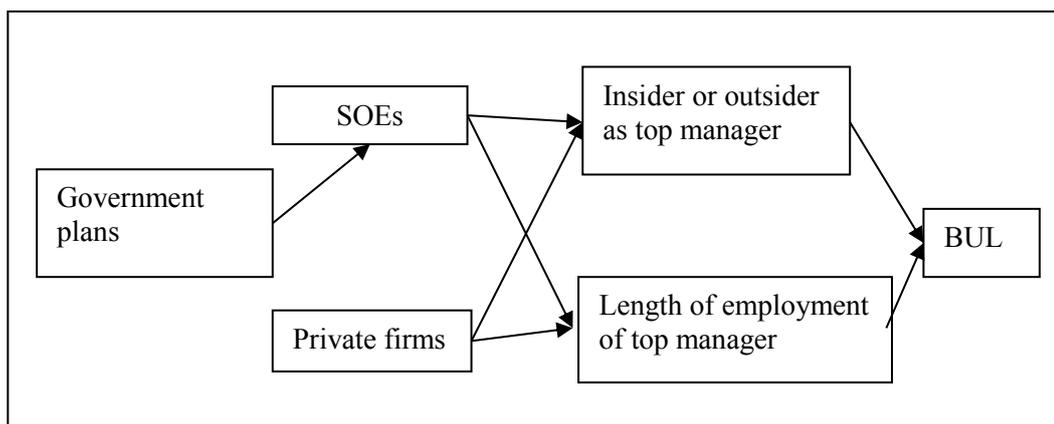
Third, the literature also points out that top managers of SOEs stay for the short term only, and they will leave after their term ends (Tylecote *et al.*, 2010). This means that the top managers only plan for short-term development of SOEs by purchasing technological bundles. However, empirical evidence shows that some local government allows top managers of SOEs to remain in position for extended periods of time if the SOEs have a good economic performance (Liu and Tylecote, 2010). Therefore, this research will include **the length of top manager's employment** as a factor that could influence the firm's innovation activities.

Focusing on discussing CG of SOEs in China does not imply that private firms are not important in China's economy. As shown in Table 2-3, the vast majority of firms in China's "Basic and Pillar Industries" are private firms. Therefore, the importance of studying private firms should not be underestimated. Tylecote and his colleagues have conducted a few cases studies of private firms using their model (e.g. Tylecote, Cai and Liu, 2010; Liu and Tylecote, 2016). In the case study of a Chinese private telecom firm-Huawei, it is pointed out that the firm's success could partly be owing to the long-term employment of their CEO Mr Ren (Tylecote, Cai and Liu, 2010) who is one of the

founders of the firm who has remained as the CEO until now. Being the CEO of the firm for nearly 30 years, there is no doubt that Mr Ren has developed a high level of firm-specific knowledge making him an insider top manager. Moreover, the study on Delixi – a private tool manufacturer also illustrates that the insider manager and the long-term employment of the top manager contributes to the firm’s product and process innovations (Liu and Tylecote, 2016). Therefore, although private firms are not owned by government, it is reasonable to assume that they still face the other two CG factors, which is whether their top manager is an insider or an outsider, and the length of the top manager’s employment.

Based on the literature reviewed, it is found that firms build their technical innovation capability in different ways, which is dictated by differences in their CGs. The differences exist in two areas. First, whether the top manager of a firm is insider or outsider. Second, the length of employment of the top manager.

Illustration 2-3: Conceptual construct of corporate governance and firm’s BUL



Because this research aims to study the impact of China’s NSI on BUL in China’s firms, these two differences are used as two factors within CG in this research to study how CG influences a firm’s BUL.

The conceptual construct of corporate governance and a firm's BUL is illustrated in Illustration 2-3.

At this stage, the literature that discussed the diversity of SOEs in China needed to be addressed. The existing literature identifies some distinctions amongst firms owned by the government at different levels in China. Two types of firms are mostly discussed in the literature including SOEs owned by the central government ("central SOEs" in this thesis), and firms owned by township and village governments, which named township and village enterprises (TVEs) (Nee, 1992; Nee, 1996; Nee *et al.*, 2007; Nee *et al.*, 2010; Peng, 2001; Wong *et al.*, 2004).

TVEs in China represent a fascinating group of collectivist firms that are profit-driven and managed almost directly by officials in lower level governments. However, the TVEs are not "local SOEs" based on how the Chinese government classifies SOEs. Local SOEs in China are SOEs owned by city or provincial level governments, and managed by local SASAC (labelled as "local SOEs" from this point in this thesis). The local SOEs mainly emerged after 2004, time of which the central government has authorised provincial and city level governments to establish their own SASAC to manage SOEs in their locality.

Compared to TVEs, local SOEs are often larger in size and produce more complex products including heavy machinery, automobiles, precision instruments and so on. Consequently, the local SOEs are more R&D intensive than the TVEs, which mainly produce agricultural products and fast-moving consumer goods. Therefore, the literature finds that Chinese government at different levels manages firms differently, yet fails to include local SOEs into these studies.

Local SOEs have distinctive nature from TVEs. This is because TVEs are often established by township or village governments directly to make use of local resources and the residual work force (often farmers). While, local SOEs often originate from central SOEs that were gradually decentralised by the central government to the provincial and city level government as a result of several SOE reforms since the 1990s (Krug, 2007).

Although this group of literature did not specifically study local SOEs, it provides some insights on why SOEs are managed differently by the government at different levels in China. Four main explanations have been identified from the literature.

First, the management ties (*guanxi*) between top managers of SOEs with the government gives SOEs easy access to capital (Peng and Luo, 2000). The management ties are easier to form between local government and local SOEs. The reasons are twofold. 1) This is highly related to how top managers of the local SOEs are selected. According to Ge *et al.* (2014) some governments tend to appoint industrial specialists as top managers of SOEs in their locality. 2) Such governments tend to maintain a close relationship with top managers of local SOEs giving them both financial and policy support. Therefore, the management tie between local SOEs and local officials grants the local SOEs with easy access to capital.

Second, officials at the local government level have less SOEs to oversee in comparison to the central government, so they have the capability to manage them more efficiently (Nee *et al.*, 2007). Local officials could manage and monitor SOEs in their locality more efficiently than officials in the central government because those local SOEs are already deeply embedded in local settings. “Local embeddedness” of firms (Krug, 2007: 123)

allows trust to be established more easily in a local environment. Decentralisation of SOEs in the 1990s transferred central SOEs to be owned and managed by provincial and city level governments (ibid). The local SOEs often have years of history of hiring local employees and interacting with the local governments. Once the ownership of some of SOEs transferred from the central to the local governments, the top managers of the SOEs are able to establish trust with the local officials easily. This is because those SOEs are locally embedded after years of interacting with the local governments. Thus, the local officials are willing to give more freedom to top managers of the local SOEs.

Third, local officials are assessed by the speed of economic growth in their jurisdiction, they consider local SOEs as core economic drivers, thus, giving the local SOEs all the necessary freedom to generate profit (Nee *et al.*, 2007). Such profit-driven local SOEs are the result of fiscal reforms that allow the local government to retain most of the profit made by the local SOEs apart from their taxation (Zhu and Krug, 2007). In addition, top managers of the local SOEs are often offered bonus if the company performs well, so their income is closely linked to the overall profit of the firm (Liu and Tylecote, 2009). Thus, both top managers of the local SOEs and the local officials have incentives to maximize profits and to efficiently run the local SOEs.

Fourth, the local government is allowed to have its own industrial plans, some of which may differ from central government plans, local SOEs do not have to prioritise state objectives (Fuller, 2016). Therefore, the local SOEs are more market driven than central SOEs given that the local government tends to manage the local SOEs with profit-driven goals as mentioned above in point three. This could also explain why local officials manage local SOEs in different ways.

Although a few explanations, as listed above, have been found in the literature that theoretically suggest local SOEs could be managed differently from central SOEs, there is still a lack of direct empirical evidences supporting this argument. Therefore, central SOEs and local SOEs will continue being grouped as a single construct labelled “SOEs” as shown in Illustration 2-2.

2.4.4 Firm’s access to capital

Another important part of the CG&Fs model (Tylecote and Conesa, 1999), which has also been recognised as crucial by Lazonick and O’Sullivan (1996) as a financial commitment condition, is the financial system within NSI. Therefore, this sub-section reviews the literature that focus on how a firm’s access to financial capital influences their innovation activities.

Various studies found that China’s SOEs have privileged access to scarce capital in comparison to private firms (Liu and White, 2001; Boisot *et al.*, 2011; Tylecote *et al.*, 2010; Xue *et al.*, 2011; Okazaki, 2017). Studies by Peng and Luo (2000) and Yiu and Lau (2008) argue that SOEs in China receive cheap and easy financial capital, as well as other forms of capital.

Peng *et al.* (2005) and Yiu and Lau (2008: 36) developed the “network-based resource capital model” which includes three types of capital that firms have access to in emerging economies like China, namely *political capital* – which represents government support, *social capital* – that is inter-firm collaborations, and *reputational capital* – where awards are issued by authorities and promotes collaboration within public research institutes. Two of the three forms of capital are of particular interest to this research, namely political capital and reputational capital because it is mainly the government that provides these

two types of capital to firms. Social capital relies mainly on inter-firm connections so this is not the focus of this research. Therefore, social capital will not be discussed here.

Political capital represents various types of favourable policies and resources provided by the government to firms (Yiu and Lau, 2008). Reputation capital is facilitated by the government to provide firms with advantages in the marketplace (ibid). The detailed types of capital within those two categories of capital is listed in Table 2-7.

Although Yiu and Lau (2008) have listed detailed forms of capital under “political” and “reputational” capital, most of them are financial capital provided either directly or indirectly by the government. Amongst *political capital*, “easy loans from bank” is a form of financial capital provided by the government indirectly through the banks. “Tax relief” is a form of financial capital provided directly by local government. Amongst *reputational capital*, “government purchase”, “funding for R&D from government” and “award issued by authorities” are all financial capital provided directly by local government. “Award issued by authorities” can be viewed as direct financial capital from the government because the government often gives financial rewards together with the award issued to firms.

Since this research only aims to distinguish whether SOEs have access to a larger amount of financial capital provided by the government, the previously listed forms of capital will be grouped and labelled as “**financial capital**” regardless of whether firms receive it directly or indirectly from the government.

Amongst the various forms of political capital, “technical training provided by the government”, “management knowledge provided by the government through training” and “access to certain human capital” are all related to human resource management of

firms. Thus, they will be grouped as “**human resource capital**”. This group of capital is included in this research because it is reasonable to propose that having access to high quality human resource could help a firm to adopt BUL. It is because BUL for innovation relies on the level of knowledge possessed by all members of the firm.

“Information on market and technological trends” and “joint R&D projects with university and PRIs” are also important forms of capital that the government provides. However, the link between the two forms of capital with BUL is difficult to build. Therefore, these two forms of capital are not included in the analysis in this research.

Table 2-7: Types of capital in Political capital and Reputational capital

	Type of capital in detail	Nature of Capital	Label of Capital
Political Capital	Easy Loan from banks (Easy loan)	Indirect Financial	Financial
	Tax relief	Direct Financial	Financial
	Technical training provided by government (Technical training)	Human resource	Human resource
	Management knowledge provided by government through training (Management knowledge)	Human resource	Human resource
	Information on market and technological trends	Irrelevant	N/A
	Access to certain human capital (Human resource)	HR	Human resource
Reputational Capital	Joint R&D project with university and PRIs	Irrelevant	N/A
	Government purchase	Direct Financial	Financial
	Funding for R&D from government	Direct Financial	Financial
	Awards issued by authorities	Direct Financial	Financial

Source: Adapted from Yiu and Lau, 2008

The level of a firm’s access to capital has an impact on the firm’s innovation activities. Jiang *et al.* (2013) point out that private firms in China are mainly engaged in developing incremental innovations in product design and production processes due to their lack of

capital to invest in developing radical innovations. Therefore, with different levels of access to capital, SOEs and private firms are expected to have BUL. Because the BUL approach mainly develops incremental innovations, private firms may have more BUL than SOEs.

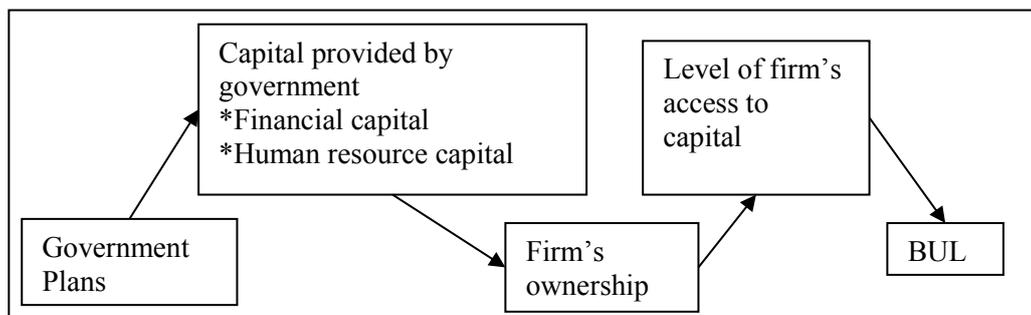
Based on the literature, the level of a firm's access to capital is used as an institutional factor that influences a firm's BUL. It expands the financial system factor in the CG&Fs model by using financial capital and human resource capital.

Moreover, various scholars argue that private firms in China have low levels of access to scarce capital in comparison to SOEs (Cai and Tylecote, 2005; Liu and White, 2001; Tylecote, 2010; Xue *et al.*, 2011; Okazaki, 2017), which suggests that a firm's ownership has an impact on the level of capital that the firms could access.

In addition, based on the work by Yiu and Lau (2008), both financial capital and human resources capital are provided by the government so government plans influence what capital firms could have.

Therefore, the conceptual construct of a firm's access to capital is developed in the Illustration 2-4.

Illustration 2-4: Conceptual construct of firm's access to capital



2.4.5 Remarks on NSI literature

This section reviews NSI literature in five areas, namely China's NSI, CG and innovation in general, CG and innovation in China's firms, and a firm's access to capital in China's NSI.

A few crucial insights are found that helps guide this research in the following empirical investigation on the impact of China's corporate governance system, and a firm's access to capital on the firm's BUL.

First, the literature on China's NSI points out that China is still a planned and centrally controlled economy in the strategic sectors. It is because China's government controls these sectors by establishing SOEs, and directs SOEs by making plans for technological development (Xue, 1997; Xue *et al.*, 2011; Motohashi and Yun, 2007; Liu, 2009; Boeing and Sandner, 2011). Therefore, state-ownership within the corporate governance system is a key institutional factor of China's NSI.

Second, the review of the literature shows that the government's appointment of top managers to China's SOEs causes two CG problems. First, the government usually appoints outsiders as top managers to SOEs by. Because outsiders do not have the firm-specific knowledge, they do not observe and appreciate low-visibility innovation activities (Cai and Tylecote, 2005; Tylecote and Visintin, 2008; Liu and Tylecote, 2016). Second, the government tends to appoint top managers for short-term employment, which makes them plan only for the short-term development of the firm and they avoid following slow-pay-off innovation activities (Liu and Tylecote, 2009; Tylecote, Cai and Liu, 2010). It is also found that private firms also face two corporate governance issues based on findings by Tylecote *et al.* (2010) and Liu and Tylecote (2016). The difference

between SOEs and private firms is that top managers of private firms are appointed by the shareholders.

Third, it is found that SOEs in China have privileged access to capital more than private firms (e.g. Cai and Tylecote, 2005; Liu and White, 2001; Tylecote *et al.*, 2010; Xue *et al.*, 2011; Okazaki, 2017). It is proposed that SOEs and private firms in an emerging market like China receive political and reputational capital from the government, but SOEs receive more capital than private firms (Peng, Lee and Wang, 2005; Yiu and Lau, 2008). Political and reputational capital are mainly financial and human resource capital in nature. Furthermore, empirical evidence shows that private firms in China only develop incremental innovations due to lack of access to capital (Jiang *et al.*, 2013). Because BUL mainly develops incremental innovations, private firms may have more embedded BUL practices than SOEs.

From those insights found in China's NSI literature, two more research questions are raised here to follow up on empirical investigations for understanding the impact of institutional factors in China's NSI, namely corporate governance and a firm's access to capital on its BUL.

Research question 2:

“How the level of firms' BUL embeddedness varies amongst firms with different ownership?”

Research question 3:

“How does China's corporate governance system and firms' access to capital influence the adoption of embedded BUL practices in firms ?”

2.5 Conceptual Framework Based on Literature

2.5.1 Research questions

Based on insights drawn from the literature discussed in this chapter, three research questions have been proposed to address the overall research objective, which is to understand the impact of China's NIS on a firm's innovation activities.

However, it is beyond the author's capability to study all institutional factors within China's NSI, two sets of institutions have been chosen, based on the literature review, to develop a better understanding of China's NSI. Two sets of institutions are the corporate governance system, and a firm's access to capital.

In addition, BUL is studied as one form of innovation activity aiming to develop long-term innovation capability firms based on the successful experience of Japanese firms in engineering sectors (Lam, 2002; Lam and Lambermont-Ford, 2010). BUL is crucial to firms in engineering sectors because the technological development of engineering sectors depends on continuous incremental innovation in product design and production processes (Nelson, 2004; Nelson and Winter, 1982).

Therefore, the refined research objective in this research is to understand the impact of CG and the firm's access to capital for the firm's BUL. It could be further translated into three research questions as follows.

Research question 1: *“Do China's firms have bottom-up learning (BUL) practices to develop their innovation capability, and how embedded are BUL practices?”*

Research question 2: *“How the level of firms' BUL embeddedness varies amongst firms with different ownership?”*

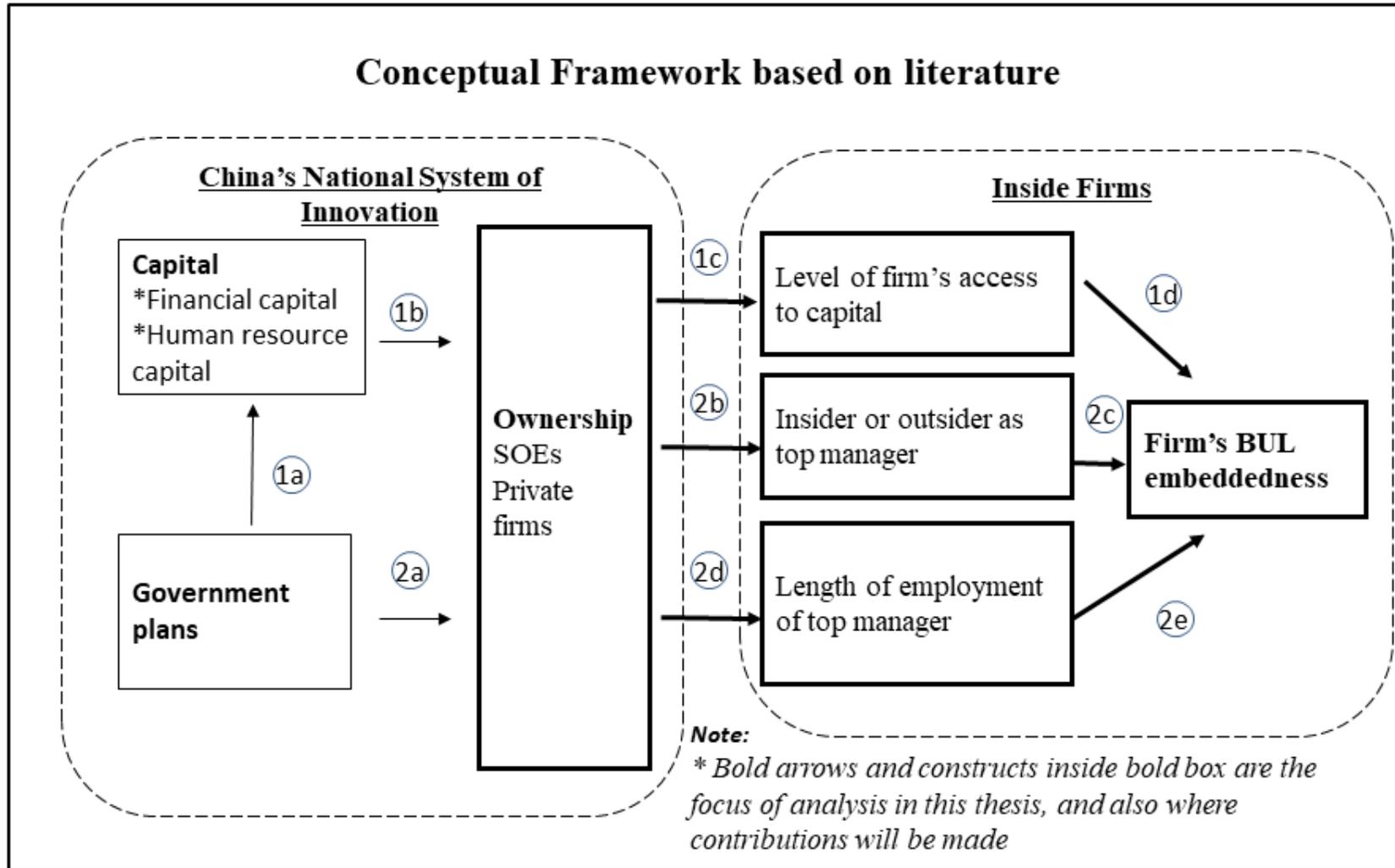
Research question 3: *“How does China’s corporate governance system and firms’ access to capital influence the adoption of embedded BUL practices in firms?”*

2.5.2 Conceptual framework

Based on the conceptual constructs developed from the literature (See Illustration 2-3 and Illustration 2-4), a conceptual framework is developed as explained in the following paragraphs.

It needs to be noted that, in order to identify patterns during data analysis, this research proposes a term named the level of BUL embeddedness of firms. The level of BUL embeddedness is defined as the number of embedded BUL practices a firm has adopted compared to other cases studied in this research. It allows the author to group cases based on the number of embedded BUL practices adopted by firms. (See Section 2.5.3 on page 103 for more detail).

Illustration 2-5: Conceptual framework from literature



Link 1a and link 1b denote the impact of government plans on what capital is provided to firms with different ownership, namely central SOEs, local SOEs and private firms. Based on work by Yiu and Lau (2008) capital has been divided into financial capital and human resource capital. SOEs and private firms will receive both financial and human resource capital from the government, but to different levels.

Link 1c denotes that the ownership of a firm's influences the firm's access to capital provided by the government. It is argued that SOEs have privileged access to capital provided by the government in comparison to private firms (e.g. Cai and Tylecote, 2005; Liu and White, 2001; Tylecote *et al.*, 2010; Xue, Liu, and Mu, 2011; Okazaki, 2017). Therefore, the central and local SOEs are expected to have access to a high level of financial and human resource capital, but private firms would have limited access to capital.

Link 1d denotes that the level of firms' access to capital could influence a firm's BUL. Jiang *et al.* (2013) point out that the private firms in China are mainly engaged in developing incremental innovations in product design and production processes due to the lack of capital to invest in developing radical innovations. Therefore, with a low level of access to capital, private firms are expected to have higher BUL embeddedness. Because the BUL approach mainly develops incremental innovations, private firms may have more embedded BUL practices. On the country, SOEs might have a low level of BUL embeddedness. Because they have access to a high level of capital, they could afford to develop radical innovations that do not rely on BUL. Therefore, this link explains whether access to capital influences the top managers' capability to engage with innovations

Link 2a denotes that government plans influence the corporate governance of SOEs by appointing the top manager directly by SASAC (Liu and Tylecote, 2009, Tylecote *et al.* 2010; Xiao *et al.*, 2013).

Link 2b denotes that the government could appoint either an insider or an outsider as a top manager to SOEs. If the top managers do not have firm-specific knowledge before he/she is appointed, he/she is considered as an outsider. On the contrary, if the top manager has rich firm-specific knowledge when he/she is appointed, he/she is considered as an insider.

Link 2c denotes that the level of a top manager's firm-specific knowledge could influence their tendency to adopt embedded BUL practices. An outsider lacks the firm-specific knowledge, so they are not capable of observing and appreciating low-visibility innovation activities (Tylecote and Visintin, 2008) like BUL. Therefore, firms with outsider top managers are likely to have a low level of BUL embeddedness. Conversely, firms with insider top managers are likely to have a high level of BUL embeddedness.

Link 2d denotes that the government could appoint the top manager for either short-term or long-term employment. If the top manager remains in position for more than ten years, he/she is considered as being appointed for the long-term.

Link 2e denotes that the length of a top manager's employment could influence the firm's BUL. This link explains whether top managers are given incentives to adopt BUL practices. It is argued that the short-term appointment of top managers to SOEs is one of the major issues to SOEs in China because it forces the top manager to make short-term plans in developing innovation capability (Tylecote, Cai and Liu, 2010). Because the career development and personal gains of a short-term manager are not closely tied to the

long-term development of firms, short-term top managers tend to purchase readymade technologies since they could produce short-term benefits in increasing profit and boosting production rates (Liu and Tylecote, 2009). Consequently, firms with short-term top managers are likely to have a low level of BUL embeddedness. Because BUL is a slow-pay-off way of developing long-term innovation capability, the incentive of short-term top managers to adopt embedded BUL practices is low. While long-term top managers, who normally plan for the long-term development of a firm's innovation capability, are more likely to adopt embedded BUL practices. Therefore, the level of BUL embeddedness in firms with long-term top managers is likely to be high.

It needs to be noted that, the government cannot appoint top managers to private firms. However, private firms still have the problem denoted by links 2c and 2e. Insider or outsider top managers in private firms, being appointed by shareholders for either short-term or long-term, are still likely to face problems similar to those denoted by links 2c and 2e.

The focus of analysis is on those constructs marked by bold boxes and the interaction between them is marked by bold arrows in Illustration 2-5.

2.5.3 Research assumptions

Based on the literature reviewed in this chapter, three assumptions are developed to guide this research. These three assumptions justify why firms should have BUL to develop innovation, why BUL requires long-term planning by top managers, and why BUL requires top managers to have firm-specific knowledge. The three assumptions are developed from the literature, thus they are theoretically justified.

The literature shows that a firm's internal knowledge and an employee's personal knowledge help innovations (e.g. Patel and Pavitt, 1994; Dosi, 1988; Nelson, 2004) (see Section 2.3.3 for details). Moreover, utilising an employee's knowledge repository results in the development of innovation capability and improved innovation performance (Bessant and Caffyn, 1997; Lam, 2002; Høyrup, 2010; Wei *et al.*, 2011; Lee and Walsh, 2016). Furthermore, it is argued that a firm's competitive advantage depends on its innovation in a competitive market (O'Sullivan, 2000). Finally, Porter (2008) suggests that a firm's sustained competitive advantage leads to its superior economic performance. Therefore, this research proposes that:

Research assumption 1:

BUL leads to improved innovation capability and better innovation performance, which consequently leads to improved economic performance. --- Thus, top managers of firms will adapt BUL practices if they want to have good innovation along with improved economic performance.

It is argued that innovation is cumulative in its process because it requires continuous learning (Pavitt, 1987; Dosi, 1988; Tidd, Bessant and Pavitt, 2005; Lundvall, 2010). As a learning approach based on an employee's daily working experience, BUL is likely to need time before its benefits could be observed. Therefore, this research proposes that:

Research assumption 2:

BUL practices require long term investment before their benefits can be perceived in terms of better innovation capability or performance. --- Thus, top managers who might only remain in their position for 4-5 years are less likely to adapt embedded BUL

practices, as they are unable to anticipate the benefit of those practices within their period of employment.

As discussed in Section 2.4.2, innovation activities in mid-high-tech sectors are less visible to outsiders due to their lack of firm-specific knowledge (Tylecote and Conesa, 1999; Tylecote and Ramirez, 2006; Tylecote and Visintin, 2008). This is because radical innovations are developed slowly by the accumulation of continuous incremental innovations from problem-solving on the shop floor in some sectors (Tidd *et al.*, 2005; Lundvall, 2010), such as the automobile sector (Tylecote and Visintin, 2008). Without sufficient firm-specific knowledge, top managers of firms are less likely to observe such innovation activities on the shop floor, therefore, they do not appreciate such activities (Tylecote and Conesa, 1999; Tylecote and Visintin, 2008). Therefore, this research proposes that:

Research assumption 3:

BUL is more difficult as it is less visible to top managers who do not have firm-specific knowledge. This is because BUL tends to occur amongst employees on a daily basis. --- Thus, outsiders who do not have sufficient firm-specific knowledge are less likely to have an awareness of the BUL activities taking place on the shop floor. Even if they noticed such learning activities, they would not adapt BUL practices or facilitate them as they are unaware of the benefits of such learning efforts.

2.5.4 List of BUL practices for this research

Nine BUL practices have been identified from literature spanning four disciplines, namely knowledge management (KM), organisational learning (OL), human resource management (HRM) and operation management (OM). These practices are listed in Table

2-8. These BUL practices will be empirically investigated in firms at a later stage of this research.

Moreover, these BUL practices will be evaluated in terms of whether or not they are embedded. It is of particular interest to this research because this research aims to study BUL practices in Chinese firms. As already discussed in detail in Section 2.3.1.5, having an effective Kaizen structure is a challenging task for firms in countries other than Japan, due to cultural differences (Bateman and David, 2002; Bessant *et al.*, 1994; Doeringer *et al.*, 2003; Aoki, 2008). This problem not only appears in countries that have broad cultural differences like in the UK and the US, but also exists in countries that historically have similar cultures to China (Aoki, 2008). It also suggests that BUL could face a similar challenge as firms could have some BUL practices, but these practices may not be managed well and thus do not benefit the innovation capability of those firms.

Therefore, this research also evaluates the embeddedness of the nine BUL practices in firms. The level of embeddedness of a BUL practice means whether the BUL practice is an embedded (functioning) practice that help firms to develop their innovation capability, or not embedded (not functioning) practice that only exists on paper. Criteria used for distinguishing embedded and not embedded BUL practice will be developed based on the literature in the research methodology chapter to guide data analysis in the later stages of this research (see Section 3.6.1.1.).

Moreover, in order to identify patterns that occur during data analysis, this research proposes a term named “the level of BUL embeddedness of firms”. The level of BUL embeddedness is defined as the number of embedded BUL practices a firm has adopted

in comparison to other cases studied in this research. It allows the author to group cases together based on the number of embedded BUL practices adopted by some firms.

Table 2-8: Summary of BUL practices in the literature

BUL practice	Discipline	Reference
Informal event	KM	Hoegl and Schulze, 2005
Expert mapping	KM	Hoegl and Schulze, 2005
Record keeping of problem-solving activities at work	KM	Hoegl and Schulze, 2005; Nonaka, Toyama, and Konno 2000
Multi-disciplinary team for problem-solving	OL	Lam, 2002; Bolton, 1993; Bessant <i>et al.</i> , 1994; Nonaka and Takeuchi, 1995; Doeringer <i>et al.</i> , 2003; Aoki, 2008)
Job rotation	OL	Coşgel and Miceli, 1999; Ortega, 2001; Lam, 2002; Lorenz and Wilkinson, 2003; Arundel <i>et al.</i> , 2007; Preenen <i>et al.</i> , 2017
Training employees on both work-related and non-work-related topics,	HRM	Shipton <i>et al.</i> , 2006
Appraisal system that promotes knowledge sharing with co-workers,	HRM	Shipton <i>et al.</i> , 2006
Contingent rewarding system	HRM	Shipton <i>et al.</i> , 2006
Internal training	HRM	Lau and Ngo, 2004; Shipton <i>et al.</i> , 2006; Sung and Choi, 2014; Caloghirou <i>et al.</i> , 2018; Dostie, 2018
Proposal system	OM	Bessant and Caffyn, 1997; Aoki, 2008; Aoki <i>et al.</i> , 2014; Lasrado <i>et al.</i> , 2015; Laviolette <i>et al.</i> , 2016; Lasrado <i>et al.</i> , 2017

2.6 Chapter Conclusion

This chapter began by reviewing innovation literature to develop a better understanding of how innovations are developed. It is found from the innovation literature that the knowledge repository of employees is a crucial source for a firm's incremental innovations and that is of particular importance in engineering sectors.

A further review of the literature on the bottom-up learning (BUL) approach proves it is a viable approach that promotes the utilisation of the knowledge repository of employees for developing incremental innovations.

Moreover, on reviewing China's NSI literature it is clear that a firm's BUL could be influenced by two main institutional factors, namely its corporate governance system and the firm's access to capital. The corporate governance factor is further divided into 1) the management appointment of an insider or an outsider as the top manager of a firm and 2) the length of employment of the top manager, according to literature (e.g. Tylecote and Conesa, 1999; Miozzo and Tylecote, 2001; Tylecote *et al.*, 2002; Cai and Tylecote, 2005; Tylecote and Ramirez, 2006; Tylecote, 2007; Liu and Tylecote, 2016).

Finally, a conceptual framework has been developed to study how CG and a firm's access to capital (including financial capital and human resource capital) influences those firms' BUL. Because CG and a firm's access to capital are two major factors in China's NSI, and BUL is an important form of learning activity in firms who rely on incremental innovations, like firms in the automobile sector. This research aims to develop a better understanding of the impact of China's NSI on firm's innovation activities.

Chapter 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter aims to identify an appropriate philosophical stance, research methods, and the research designs of the fieldwork. Three key questions in terms of the research methodology are answered in this chapter, namely 1) what is the philosophical stance that guides the development of knowledge in this research, 2) what research methods are selected to collect and analyse data to address the research questions, and 3) how research methods are operationalised with an appropriate research design for conducting fieldwork and empirical investigation.

To answer the three questions listed above, this chapter is organised as follows: Section 3.2 identifies the philosophical stance of this research to guide the development of knowledge. Section 3.3 justifies the choice of the case study as the research method for conducting fieldwork. Section 3.4, develops the research design to operationalise the case study method selected. Section 3.5, explains the data collection method. Section 3.6 explains the data analysis method. Section 3.7 discusses the validity tests for this research. Section 3.8 discusses ethical considerations in this research. Section 3.9 concludes this chapter by summarising the key points discussed.

3.2 Philosophical Stance

Valid research findings are underpinned by underlying assumptions about reality and appropriate research methods (Morgan and Smircich, 1980). It is important to clearly state the philosophical stance of this research because it determines the underlying assumptions of what is reality, and how a knowledge of reality could be developed (Easterby-Smith *et al.*, 2008). Therefore, this section discusses mainstream research philosophies applied in

management research to identify the most appropriate example to address the research questions.

3.2.1 Research Philosophies in management studies

Various research into philosophical perspectives have been applied to management research, including two main contrasting ontological positions, namely objectivism advocated by positivists, and subjectivism advocated by social constructionists (Saunders *et al.*, 2009). Positivists believe that social reality is objective and independent from interpretation by people (Easterby-Smith *et al.*, 2008). While, social constructionists argue that social reality is subjectively constructed by a collection of people's interpretation and understanding (Easterby-Smith *et al.*, 2008). The two viewpoints of social reality are the foundations of positivism and social constructionism, which are epistemology positions concerning how a knowledge of reality could be developed (Easterby-Smith *et al.*, 2008; Saunders *et al.*, 2009).

Thus, the positivistic management research tends to study social reality by using quantitative measures to objectively investigate causal-effect relationships within social phenomenon (Easterby-Smith *et al.*, 2008; Cassell and Symon, 2004). However, social constructionist management research tends to study social reality by explaining different human experiences in a social environment (Easterby-Smith *et al.*, 2008).

3.2.2 Philosophical stance of this research: Critical-realism

Critical realism is an epistemological position sited between positivism and social constructionism. Critical realists admit the reality exists externally to its observer (i.e. the researcher) but argue that reality exists in three domains, that could not be fully

understood without human interpretation (Bhaskar, 1978; Bhaskar, 1986; Bhaskar, 1989; Blaikie, 1993; Fleetwood, 2014).

Bhaskar (1978) argues that the reality of social phenomenon exists in three domains:

The empirical domain consists of an observable part of the social phenomenon. Relating to this research, it could include the corporate governance of firms, BUL practices adopted by firms, the level of market competition, and a firm's access to capital.

The actual domain consists of observed and not observed parts of social phenomenon. In this research, it could be the top manager's decision-making process regarding the adoption of BUL practices and their incentive to make long-term or short-term plans to develop innovation.

The real domain consists of the underlying mechanism that caused the social phenomenon (at the actual domain). Relating to this research, it could be the mechanism consisting of two elements of China's NSI influence on a firm's BUL for innovation activities.

From the three domains of reality authored by Bhaskar (1978) it is evident to see that understanding the reality is difficult or unachievable without involving human interpretation. For example, observable parts of the social phenomenon are more objective and exist independently from researchers' interpretations, like management practices, the firm's structure, and so on (Chia, 2002). However, at the actual domain, the parts that are not observable would require the researcher to understand the wider environment where social phenomenon is embedded (ibid), like the decision-making

process of managers, and how their personality, culture and religion influences their decisions.

Understanding of the social environment is critical because critical realists aim to discover the underlying mechanism to social phenomena trying to explain “how” and “why” something happened (Ekström, 1992).

This research aims to investigate the underlying mechanism of how two elements of China’s NSI influences a firm’s innovation activities. Three research questions have been raised, and all of them are “how” and “why” questions. Therefore, the critical realism epistemology position is in line with the objective and questions of this research.

This research admits the corporate governance of firms, firms’ access to capital, the level of market competition, and BUL practices in firms, exist externally to the researcher. However, how each factor influences the top manager of firms in decision-making is a part of the social reality that is not observable. Thus, to discover and formulate the underlying mechanism that explains the interaction between factors, the author’s understanding of the social environment is necessary.

3.3 Research Method: Case Study

Yin (2009) summarises five most commonly used research methods in management research with corresponding situations and forms of research questions (see Table 3-1).

This section justifies why the case study method is selected in this research and how it helps address the research questions.

Table 3-1: Relevant Situation for Different Research Method

Method	Form of research questions	Requires control of behavioural events?	Focuses on contemporary event
Experiment	How, why	Yes	Yes
Survey	Who, what, where, how many, how much	No	Yes
Archival Analysis	Who, what, where, how many, how much	No	Yes/No
History	How, why	No	No
Case Study	How, why	No	Yes

Source: COSMOS Corporation cited in Yin (2009: 8).

3.3.1 Nature of this research and the Case study method

Yin (2009:18) defines the case study method as: “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident.”

This research aims to study the impact of two elements of China’s NSI on a firm’s BUL. All three research questions are “how” and “why” questions.

The first research question is “Do China’s firms have bottom-up learning (BUL) practices to develop their innovation capability, and how embedded are BUL practices?” This question aims to investigate what BUL practices have been adopted by firms, how do they design their practices and how embedded are their practices.

The second research question is “*How the level of firms’ BUL embeddedness varies amongst firms with different ownership?*” This question aims to analyse how the ownership of firms influences their level of BUL embeddedness.

The third research question is “How does China’s corporate governance system and firms’ access to capital influence the adoption of embedded BUL practices in firms?” This question aims to use the conceptual framework in this research to analyse how two sets

of institutions of China's NSI influence the level of BUL embeddedness of firms. This question aims to formulate a causal-explanatory mechanism to explain relationships between two sets of institutions of China's NSI and a firm's BUL activity.

Based on Table 3-1, experiment, history and the case study are considered to address the "how" and "why" research questions.

This research studies a contemporary event that is currently how China's NSI influences firms' innovation behaviour in general. Therefore, the history method is not an appropriate method for this research.

The experiment method is used when research could "manipulate behaviours directly, precisely, and systematically" often in a laboratory environment (Yin, 2009: 11). For this research, the manipulation of top managers' behaviour is not needed. Therefore, the experiment method is also rejected.

Therefore, this research uses the case study method to address its research questions.

Yin (2009) proposes three types of case study research, namely descriptive, explanatory and exploratory. This research involves all three types of case study. The first research question investigates what BUL practices firms have adopted and how embedded those practices are based on their operational details. The findings would be both exploratory and descriptive. The research questions two analyses of how the adoption of BUL practices varies amongst firms with different ownership. The finding for this question would be exploratory. The third research question studies how China's corporate governance system and a firm's access to capital influences the level of BUL embeddedness. The findings will be explanatory. Therefore, the case study method is deemed suitable to address all three research questions.

3.3.2 Critical realism and the case study method

A deductive research strategy is often used in positivistic research when the aim is to develop generalisable theories objectively through testing the hypothesis developed from existing literature with quantitative methods, whilst the inductive research is often used by social constructionist research aiming to generate a theory by identifying patterns that emerge from social phenomena with qualitative data (Yin, 2009).

This research is inductive in nature as it aims to build theories from the social phenomena studied. However, the research process also involves some elements of the deductive process when developing a conceptual framework from the literature to guide the empirical investigations.

It is proposed that critical realism studies represent an underlying mechanism of social phenomena (Bhaskar, 1978) and aims to understand the not observable part of social reality that is not fully understood. It is suggested that a case study focus works well and precisely for studying research areas that have not yet been fully revealed (Bonoma, 1985; Eisenhardt, 1989; Yin, 2009). Therefore, the case study method is in line with the philosophical stance of this research.

3.4 Research Design and Instrument Development

Eisenhardt (1989) proposed a nine-step procedure for building theory from the case study research listed in Table 3-2.

Easterby-Smith *et al.* (2008) suggest that Eisenhardt's (1989) framework is in line with critical realism and is suitable for theory generation. Therefore, the instrument development process in this research is based on this framework.

Table 3-2: Process of building theory from case study research

Step	Activity	Reason
Getting Started	Definition of research question Possibly a priori constructs	Focuses efforts Provides better grounding of construct measures
Selecting Cases	Neither theory nor hypotheses Specified population Theoretical, not random, sampling	Retains theoretical flexibility Constrains extraneous variation and sharpens external validity Focuses efforts on theoretically useful cases—i.e., those that replicate or extend theory by filling conceptual categories
Crafting Instruments and Protocols	Multiple data collection methods Qualitative and quantitative data combined Multiple investigators	Strengthens grounding of theory by triangulation of evidence Synergistic view of evidence Fosters divergent perspectives and strengthens grounding
Entering the Field	Overlap data collection and analysis, including field notes Flexible and opportunistic data collection methods	Speeds analyses and reveals helpful adjustments to data collection Allows investigators to take advantage of emergent themes and unique case features
Analyzing Data	Within-case analysis Cross-case pattern search using divergent techniques	Gains familiarity with data and preliminary theory generation Forces investigators to look beyond initial impressions and see evidence thru multiple lenses
Shaping Hypotheses	Iterative tabulation of evidence for each construct Replication, not sampling, logic across cases Search evidence for “why” behind relationships	Sharpens construct definition, validity, and measurability Confirms, extends, and sharpens theory Builds internal validity
Enfolding Literature	Comparison with conflicting literature Comparison with similar literature	Builds internal validity, raises theoretical level, and sharpens construct definitions Sharpens generalizability, improves construct definition, and raises theoretical level
Reaching Closure	Theoretical saturation when possible	Ends process when marginal improvement becomes small

Source: Eisenhardt, 1989: 533

3.4.1 Case selection

3.4.1.1 Number of case

This research studies multiple cases. Eisenhardt (1989: 542) suggests using multiple cases for theory building because “each case is analogous to an experiment, and multiple cases are analogues to multiple experiments”. Easterby-Smith *et al.* (2008) suggest using multiple cases helps test and validate the emerging pattern of the relationship between conceptual constructs.

Easterby-Smith *et al.* (2008) also suggest that 4-10 cases are suitable for theory building using the case study method. This research chose to study seven cases including four central SOEs, two local SOEs and one private firm.

The rationale for case selection is discussed in the following sub-sections.

3.4.1.2 Theoretical sampling

This research adopts the theoretical sampling method that is widely used in management case studies (Glaser, 1978; Eisenhardt, 1989). This is because theoretical sampling allows researchers to select cases within categories that enable them to develop comparable and generalisable results within each category (Easterby-Smith *et al.* 2008).

Moreover, Eisenhardt (1989) suggests that theoretical sampling helps identify patterns and relationships between constructs when purposely selecting cases with possible contrasting outcomes (like cases with possibly good BUL, and possibly bad BUL).

3.4.1.3 Case selection criteria

Because the theoretical sampling method is adopted in this research, a list of criteria is developed based on the research questions and existing literature. Three criteria are developed to guide the case selection process.

- a) **Mid-high-tech sector.** – As discussed in the literature review chapter, BUL is crucial to mid-high-tech sectors because these firms rely on continuous incremental innovation in their product design and production processes (Tylecote and Ramirez, 2006; Tylecote and Visintin, 2008). Based on OECD (2011) sector classification by R&D intensity, five sectors are classified as mid-high-tech sectors (see Table 3-3). Due to the limited time, resources and access to firms, this research studies two of the mid-high-tech sectors. These are the motor vehicles

sector (“automobile” sector in the following text), and the railroad equipment sector.

Table 3-3: OECD sector classification by R&D intensity, mid-high-tech sectors

Mid-high-tech sector by R&D intensity	Electrical machinery and apparatus
	Motor vehicles, trailers and semi-trailers
	Chemicals excluding pharmaceuticals
	Railroad equipment and transport equipment
	Machinery and equipment

Source: Adapted from OECD (2011: 5)

- b) **Ownership of firms.** –The literature suggests that a firm’s ownership has a significant influence on firms’ corporate governance and the level of firms’ access to capital. These factors lead to different innovation activities of the firms. Moreover, the literature suggests that private firms are more engaged with incremental innovations (Jiang *et al.*, 2013) so they are expected to have more BUL practice. While SOEs are found to only be buying ready-made technologies (Liu and Tylecote, 2009) they are expected to have fewer BUL practices. Therefore, this study studies SOEs and private firms. Moreover, as discussed at the end of Section 2.4.3, some literature (Nee, 1992; Nee, 1996; Nee *et al.*, 2007; Nee *et al.*, 2010; Peng, 2001; Wong *et al.*, 2004) suggests Chinese government at different level manage SOEs differently. This suggests that both central SOEs and local SOEs should be included in this research to avoid biases in the result. Thus, the researcher deliberately selected both central SOEs and local SOEs at the case selection stage.
- c) **Market performance.** – Because the literature suggests BUL leads to better innovation and economic performance (Bessant and Caffyn, 1997; Lee and Walsh, 2016) it would be more likely to find BUL practices in firms having a good market

performance. Being able to find BUL practices in cases is important because one of the research interests in this study is to analyse how BUL practices are designed in China's firms that are aiming to operationalise the concept of BUL. Therefore, cases are mainly selected from market-leading firms.

3.4.2 Case selection results

After several stages of negotiation with firms, seven firms have agreed to take part in this research. Four of them are central SOEs. Four of them in the automobile sector. Three of them are in the railway equipment sector. Brief details about the cases selected are listed in Table 3-4.

One special case is Case G which is a 50/50 joint venture (JV) between a central SOE and a French company. This case is considered as a central SOE in this research because the CEO of Case G states that his company is not managed by their French parent company at all. Case G only reports to its parent company in China which is a large size central SOE. More detail about these cases is included in Appendix C.

Table 3-4: Summary of case selection result

Company code	Sector	Industry	Ownership
A	Automobile	Engine production	Central
B	Automobile	Commercial vehicle production	Local
C	Automobile	Commercial vehicle production	Local
D	Automobile	Engine fuel supplying system production	Private
E	Railway equipment	Locomotive production	Central
F	Railway equipment	Pantograph production	Central
G	Railway equipment	Train coupler production	Central

3.5 Data Collection Method: Semi-Structured Interview

37 in-depth semi-structured interviews were conducted comprising respondents from 7 companies between late 2015 and early 2016. Respondents were mainly high and mid-

level managers in charge of R&D, quality management and HRM. High-level managers were interviewed because they are responsible for making decisions on what BUL practices to adopt and how each practice is designed. Mid-level managers are interviewed because they would have more experience with the operation of BUL practices.

Moreover, some shop floor employees were interviewed, when available, to triangulate information provided by their managers.

Wengraf (2001: 5) suggests that a semi-structured interview design should “have a number of interview questions prepared in advance, but such questions are designed to be sufficiently open that subsequent questions cannot be planned in advance but must be improvised in a careful and theorising way”.

Interview guidance is produced in this research based on the conceptual framework and research questions (see Appendix B). This interview guidance is provided to interviewees a week prior to the interviews to allow interviewees to gather necessary information for answering questions. However, the author deliberately asks questions in a different order based on the responses from interviewees to avoid them telling “beautiful” stories prepared beforehand. Moreover, this method is also used to allow the author to control the pace of the interviews to prevent the interviewee giving too much irrelevant information.

3.6 Data Analysis Method

At the preliminary stage of data analysis, interview data will be reduced according to the themes identified, like how a firm allows its employees to propose suggestions, and how the firm provides training to its employees.

Then data will be grouped into various tables according to themes, the type of BUL practices, the firm's ownership, the firm's access to capital, and the firm's corporate governance, based on qualitative data analysis methods suggested by Miles *et al.* (2014). Such cross-case analysis allows the author to identify emerging patterns in the data.

Because multiple interviewees have been interviewed in each of the firms studied, they often provide different information that are not in line with responses from other interviewees. Such information could be categorised into two groups. Two measures have been employed to eliminate information that are not supported by another source of data (Miles *et al.*, 2014).

First, information that has only been provided by one interviewee, and cannot be supported using others' responses or secondary data. Such information will be considered as having a low level of validity due to potential biases of the interviewee. Only information that has been provided by two and more interviewees, or what could be verified by another source of data, have been used to identify patterns, and to generate findings from data analysis.

Second, information that has been provided by multiple interviewees, but details are not in line with each other. Secondary data will be primarily used in this situation to verify the contradicting information. If secondary information is unavailable, such contradicting information will be excluded to avoid the bias of the researcher selecting information that fits the desired results.

After data has been compressed and validated, data was re-organised to identify patterns to address the research questions, using cross-case analysis and group-case analysis.

3.6.1 Cross-case analysis

The cross-case analysis addresses the first two research questions. All BUL practices in each case will be identified to explore what BUL practices firms have adopted. Then, the operational detail of each BUL practice will be discussed to evaluate how embedded are those practices.

Aoki (2008) suggests that practices in China's firms could not be effective. Therefore, all BUL practices in seven cases will be evaluated to determine whether they are embedded or not.

In this research, an embedded BUL practice means that the practice is effective and thus helps the firm facilitate BUL activities. Not embedded BUL practices are not effective in facilitating BUL activities, so they only exist on paper. Criteria for the evaluation of BUL practices will be developed based on literature in the following sub-section.

3.6.1.1 Criteria for the evaluation of embeddedness of BUL practices

The criteria for evaluating each BUL practices are developed in the following sub-sections. Because only five BUL practices have been identified in the seven cases in focus, only the criteria for these five practices will be discussed here.

Proposal system

It is widely suggested by scholars that the proposal system helps to improve firms' innovation performance by collecting and utilising suggestions from employees (Bessant *et al.*, 1994; Bessant and Caffyn, 1997; Bessant *et al.*, 2001; Aoki, 2008; Aoki *et al.*, 2014; Laviolette *et al.*, 2016). Based on the literature (Lasrado *et al.*, 2017; Lasrado *et al.*, 2015), four factors have been used to evaluate the embeddedness of the proposal system in each

case, which includes 1) leadership support; 2) system capacity; 3) employee involvement; and 4) organisational encouragement (see Table Table 3-5).

Table 3-5: Criteria for evaluating proposal system

	Embedded	Not embedded
Leadership support	Top management support	Limited management support
System capacity	Frequent (at least every six months)	Infrequently (once a year or less)
Employee involvement	All employees	Limited employees
Organisational encouragement	Heavily rewarded	Poorly rewarded

Problem-solving mechanisms

As suggested by the literature, structured problem solving helps with enabling effective learning from problems (Marksberry *et al.*, 2011; Tjosvold *et al.*, 2004; Simon, 2012). Based on experiences from the success of Japanese firms in engineering sectors, problem solving mechanisms based on multidisciplinary teams is a more effective approach to tackle problems from different angles (Womack *et al.*, 1991; Bessant and Caffyn, 1997; Nonaka and Takeuchi, 1995; Lam and Lambermont-Ford, 2010; Lorenz and Lundvall, 2010).

Based on arguments from previous literature, two factors have been selected to analyse the embeddedness of problem-solving mechanisms in each case, which includes 1) whether problem-solving activities are carried out by multi-disciplinary teams; 2) whether the problem-solving process is governed by a structured problem-solving approach (see Table 3-6).

Table 3-6: Criteria for evaluating problem-solving mechanism

	Embedded	Not embedded
Form of problem-solving	Team-based	Individual-based
Problem-solving processes	Defined and structured	Undefined and unstructured

Work-related record keeping system

Although the importance of recording or documenting employees' knowledge has been noted by various scholars, including Cyert and March (1963/1992), Nonaka and Takeuchi (1995: 64), Davenport and Prusak (1998), Nonaka *et al.* (2000), Earl (2001), and Jensen *et al.* (2007), there is a lack of literature showing how to evaluate record keeping systems. Thus, the criteria for evaluating the embeddedness of such practices are developed by the author based on general knowledge management literature.

Two criteria are used to evaluate the embeddedness of a detailed work-related record keeping system. The first criterion is whether the record keeping system is based on ICT technologies. It is suggested that using OA software could increase the efficiency and effectiveness of the documentation system used to record and manage employees' knowledge (Williams, 1996; Davenport, 1997). The second criterion is whether managers at different levels invest effort to review work records to identify problems and good practices. This criterion is important for distinguishing a record keeping system that only collects information from a system that facilitates managers learning from employees' experiences. These two criteria are summarised in Table 3-7.

Table 3-7: Criteria for evaluating Work-related record keeping system

	Embedded	Not embedded
Record management tool	Groupware or Office Automation software	Paper-based, not integrated to office system
Management review of records	Regularly reviewed by managers	Not or rarely reviewed by managers

Internal training

Although it has been widely recognised that internal training given to employees is one of the key drivers for facilitating knowledge creation (Lepak and Snell, 1999) and to improving a firm's innovation capability (Lau and Ngo, 2004; Shipton *et al.*, 2006; Sung

and Choi, 2014; Caloghirou *et al.*, 2018; Dostie, 2018), the studies on how to evaluate these training programmes are limited. Therefore, criteria for evaluating the embeddedness of internal training practices have been developed by the researcher based on previous literature on training in general and the notion of BUL.

Three criteria have been selected to evaluate embeddedness of internal training practices adopted by the cases in focus. Firstly, whether the firm involves shop floor employees in their internal training. Secondly, whether the firm has programmes to develop trainers internally amongst its employees. Thirdly, how often this internal training is provided to the employees. These criteria are summarised in Table 3-8.

Table 3-8: Criteria for evaluating internal training

	Embedded	Not embedded
Employee involvement	Including all employees, or including at least production workers	Limited to managers or senior engineers.
Internal trainer development	Have formal internal trainer development programmes	Not have formal internal trainer development programmes
Frequency of training	Frequently or regularly	Occasionally

Job rotation of employees

As suggested by the literature, job rotation for employees has a positive effect on a firm's innovation performance (Coşgel and Miceli, 1999; Ortega, 2001; Lam, 2002; Lorenz and Wilkinson, 2003; Arundel *et al.*, 2007; Martinez-Sanchez *et al.*, 2008; Preenen *et al.*, 2017). One key success factor is to have well-planned job rotation routes (Triggs and King, 2000). In addition, it has also been suggested that job rotation should focus on young and new recruits as they have the highest potential to develop knowledge in multiple fields (Ortega, 2001).

Therefore, the job rotation scheme of cases has been evaluated in two dimensions, namely 1) whether the firm has a well-planned route for employees to develop knowledge in different fields systematically through job rotation, and 2) whether job rotation is targeted to new and young employees (see Table 3-9).

Table 3-9: Criteria for evaluating job rotation of employees

	Embedded	Not embedded
Schedule of job rotation	Structured and planned	Unstructured and unplanned
Employee involvement	Including junior employees	Only limited to managers

3.6.1.2 Case groups and the definition of the level of BUL embeddedness

After each of the BUL practices adopted by the seven cases has been evaluated, a rating of the level of BUL embeddedness will be given to each case. The level of BUL embeddedness is a relative measure on how many embedded BUL practices have been adopted by cases in comparison to others.

Three levels of ratings are given to those cases studied: good BUL embeddedness, moderate BUL embeddedness, and poor BUL embeddedness.

The cases will be grouped based on their level of BUL embeddedness into three groups for group case analysis, which will be discussed later in Section 3.6.2.

3.6.2 Group case analysis

The group-case analysis addresses the third research question. Based on the level of BUL embeddedness of cases, cross-case analysis has been developed, the cases are grouped into: Good BUL embeddedness group, Moderate BUL embeddedness group and Poor BUL embeddedness group.

Each group of cases will be studied with three institutional factors trying to explain their current level of BUL embeddedness using a different combination of institutional factors that each case faces. Three institutional factors include 1) whether the top manager of a firm is an insider or an outsider, 2) the length of employment of the top manager, and 3) the firm's access to capital.

In such a way, patterns on how these three institutional factors influence firms' adoption of BUL practice could be identified.

Therefore, the group-case analysis addresses the third research question by identifying the impact of the three institutional factors on a firm's BUL embeddedness.

3.7 Research Result Validation

3.7.1 Four validity tests

Yin (2009: 40) proposed four validity tests to ensure the quality of the case study. These four validity tests are:

- a) "Construct validity" – defines the concept in focus and develops appropriate measures.

BUL is defined in this research based on synthesising existing literature. Moreover, criteria for evaluating the level of embeddedness of BUL practices are also developed based on the literature (see Section 3.6.1.1).

- b) "Internal validity" – refers to the development of causal linkage between constructs.

This research studies the impact of three institutional factors on BUL in firms by identifying the combination of institutional factors faced by each firm and compares firms in terms of their levels of BUL embeddedness.

c) “External validity” – refers to whether the research findings could be generalised.

The findings from these case studies could not be statistically generalised in the same way as quantitative studies. However, this research uses multi-cases and theoretical sampling to enable findings to become generalisable in similar contexts. This is because theoretical sampling allows researchers to select cases within categories that allows them to develop comparable and generalisable results within each category (Easterby-Smith *et al.*, 2008).

d) “Reliability” – refers to whether the research process could be replicated by other research with the same data set.

This research uses the same interview guidance with all interviews. Moreover, multiple interviewees are selected in each case to compensate any interviewee bias (Huber and Power, 1985).

3.7.2 Triangulation

Yin (2009: 116) proposes using “triangulation” as a method to verify findings from case studies by collecting data from multiple sources. This research triangulates the research results in three main ways.

First, this research interviewed multiple respondents in each case to eliminate bias in the interview data (Huber and Power, 1985). Multiple interviewees have been interviewed in each of the firms studied. This allows the researcher to compare the information provided by one interviewee with what was provided by others. Only the information that are not

in conflict with what was provided by other interviewees will be used for further data analysis, and the generation of findings.

Second, the researcher asked questions on the detailed implementation of BUL practices to avoid false information being given by interviewees. For example, when asking whether a firm has adopted an embedded proposal system, questions have been set to ask very specific details including, which part of the workforce is involved in this system; how suggestions are collected from the shop workers; how often could employees propose suggestions; what types of suggestion are expected from workers; who is responsible for assessing the usefulness of the suggestions; what is the background of the people who assess the suggestions; how are good suggestions rewarded, and so on. These detailed questions allow the researcher to know whether interviewees are telling the truth about what is really happening, or if they simply want to look good in public.

Lastly, data from different sources are used in this research (Quinn, 2002). The researcher collected a significant amount of secondary data from online news, the company's website, annual reports, documentaries, archives and so on. Moreover, the firm's internal documentation such as meeting reports, Kaizen project reports, internal newspapers, departmental reports, etc. were also acquired when permitted. These secondary data were selected as they contain information that helps the researcher to understand the history of the company in question, to explore how BUL practices are implemented by employees, and to validate the information provided by the interviewees. Thus, these data play a crucial role in the process of data analysis, and in addressing the research questions.

3.8 Ethical Concerns

Saunders *et al.* (2009) suggest that researchers should take ethical considerations into account in the research process. It is suggested that thorough ethical consideration makes respondents more cooperative (Zikmund, 2003). This research takes five steps to address ethical concerns.

First, a formal statement of the research objective, the research process and the interview process are sent to interviewees with the aim of informing them that all data collected are only used for research purposes and will be securely stored under the relevant confidentiality regulations of the University of Birmingham. A sample of the informed consent form is attached in Appendix A.

Second, during the interviews, all interviewees are notified again within the interview process, and data collection is based solely on the respondent's willingness to participate. All interviewees can withdraw from the study during and after the investigation process. In such a case the relevant interview data will be deleted.

Third, during and after the interview process, the private information of all interviewees will be protected and will not be disclosed to third parties.

Fourth, during and after the interviews, all sensitive business information related to the data collected will be safely stored.

Fifth, during and after the interviews all interviewees are formally advised that their views will not be distorted, misinterpreted or misused during the research.

3.9 Chapter Conclusion

Based on a critical realism philosophical stance, this chapter justifies that a qualitative study approach and a multiple-case study method should be applied to this research. The detailed research design, method and process that are going to be used are summarised as well. In addition, the research process is verified against four validity tests and triangulation. Finally, the ethical considerations in this research are discussed.

Chapter 4: CROSS-CASE ANALYSIS:

Analysis of Bottom-Up Learning in Firms

4.1 Introduction

This chapter aims to identify the BUL practices adopted by the seven cases studied. Moreover, this chapter evaluates the level of embeddedness of their BUL practices according to criteria developed from the literature. Furthermore, this chapter will analyse how the level of a firm's BUL embeddedness varies amongst four central SOEs, two local SOEs and one private firm.

This chapter provides empirical evidence for addressing the first two research questions:

Research question 1: *“Do China's firms have bottom-up learning (BUL) practices to develop their innovation capability, and how embedded are BUL practices?”* This question has been addressed in Chapter 5 through cross-case analysis.

Research question 2: *“How does the level of firms' BUL embeddedness vary amongst firms with differing ownership?”*

From the data analysis, only five out of nine BUL practices identified from the literature have been found in those seven cases. Therefore, this chapter only analyses those five BUL practices to evaluate the level of embeddedness of the BUL practices. Five BUL practices that were found in the seven cases include:

1. **Proposal Systems** for collecting and evaluating suggestions and solutions from shop floor workers to solve current technological problems (problems in existing production processes and product design).

2. **Problem-solving mechanisms** for technological problems at different levels of the firm in systematic ways.
3. **Work-related record keeping systems** for documenting problem-solving activities. This is a key knowledge management strategy trying to articulate tacit knowledge developed during the problem-solving process. However, records need to be regularly reviewed by managers trying to identify good practices related to improving production processes and product design.
4. **Internal training** for employees for professional skills based on internal trainers. This is an important mechanism for formal knowledge sharing between experienced employee and others.
5. **Job rotation of employees** for developing firm-specific knowledge through working in different areas.

The data analysis is organised as follows. Section 4.2 identifies BUL practices in the seven cases studied. In addition, the operational details of BUL practices will be summarised from the interview data. Based on the operational detail of each BUL practice provided by interviewees, the level of embeddedness of the practice will be evaluated based on criteria developed from the literature (See Section 3.6.1.1 for details). The BUL practice will be rated as either embedded - indicating it helps the firm to develop innovation capability through BUL, or not embedded that indicates the BUL practice only exists on paper. Section 4.3 evaluates the level of the firm's BUL embeddedness of each case based on the number of embedded BUL practices in each case. Each of the seven cases studied will be given a rating to indicate its level of BUL embeddedness, using poor BUL embeddedness, moderate BUL embeddedness and good BUL embeddedness. The level of a firm's BUL embeddedness is only a relative measure that will be used to

compare cases. It is also used to group the seven cases into three BUL embeddedness groups for further group case analysis in Chapter 5. Section 4.4 concludes this chapter by summarising core empirical findings in this research and discusses them in the context of relevant literature.

In the following analysis, the names of cases are replaced by case codes for confidentiality. A full list of case codes and their details can be found in Appendix C.

To allow readers to navigate easily, a note of cases' ownership and sector will be included in brackets after the case code. For example, Case A is a local SOE in the automobile sector. It will be presented as "Case A (Local SOE, Auto)" to remind readers. Similarly, the word "Railway" is used to show the case is in the railway equipment sector. This method will also be used in the following chapters.

The interviewees' names are protected by using codes based on their position. For example, the Vice President in Case A is abbreviated as "A-VP". This coding system will be used at the end of direct quotes made by interviewees provided in the following analysis. A full list of codes of interviewees can be found in Appendix C.

4.2 Analysis of BUL Practices in Cases

In this section, each one of the five types of BUL practices will be identified from the interview data. In addition, direct quotes made by interviewees will be used to explain the operational details of every BUL practice adopted by the cases studied. Finally, the level of embeddedness of each practice will be evaluated according to criteria developed from the literature.

4.2.1 Proposal System

Proposal Systems are used to collect and evaluate suggestions and solutions to the current technological problem in the existing production process and product design.

The proposal system is very important for collecting and managing employee suggestions. In the case of China's SOEs, their adoption of proposal systems is highly influenced by an administrative order issued by the central SASAC in 2006. In 2006, the central SASAC issued an instruction asking all SOEs at different levels to organise events with a theme of "love firm, give suggestions, and make contributions" (SASAC, 2006). This instruction could be considered as a starting point for proposal systems in all China's SOEs nowadays. Such practices were initially implemented amongst tier 1 SOEs, and was then gradually adopted by their subsidiaries over the years (tier 2 SOEs and below). In this study, proposal systems in Cases A, B, C, E, F and G all initiated this instruction from 2010 to 2013. Case D is a private firm and thus was not affected by the instruction.

The difference in the level of embeddedness of proposal systems in the seven cases will be compared in the following analysis.

Table 4-1: Criteria for embedded and not embedded BUL practices

Embedded	Not embedded
Top management support	Limited management support
Runs frequently (at least every six months)	Runs infrequently (once a year or less)
Includes all employees	Limited to senior employees
Heavily rewarded	Slightly rewarded

Moreover, flow charts of proposal systems of the seven cases are developed based on interview data and are attached in Appendix D.

The embeddedness of the proposal system is evaluated according to criteria listed in Table 4-1.

4.2.1.1 Case A (Central SOE, Auto)

In Case A (Central SOE, Auto), the firm has implemented a proposal system labelled Suggestion Scheme aiming to collect suggestions from employees since 2012. As an SOE owned by the central SASAC, their initiative to adopt the proposal system is derived from the instruction issued by the central CASAC.

The Suggestion Scheme of Case A (Central SOE, Auto) is an event-like programme which runs once a year and lasts around a month and is managed by mid-level managers at department level. Mid-managers will collect suggestions from employees in their departments once a year and choose any good suggestions to report to the high-level managers.

Employees participate in the Suggestion Scheme on a voluntary basis. Each suggestion will be rewarded with 5 RMB. At the end of the Suggestion Scheme every year, the top five suggestions will be selected by high-level management and given financial rewards. The financial reward for the top five suggestions varies every year, but on average is around 800 RMB.

However, the level of embeddedness of their proposal system is very low for two reasons.

First, according to the interviewees, the proposal system in Case A lacks management support. Lack of management support makes low-level employees fear that by offering suggestions to higher level managers will upset their direct supervisors and lead to some form of punishment. One CNC worker reports that: *“I normally just report it [suggestions] to my master because it is a terrible thing to report something to higher level management*

without telling your direct superiors. ... This will make my superiors unhappy, so will make me miserable later on... (A-CNC)". This indicates that the high-level managers do not show strong support to employees who propose suggestions directly to them. In addition, responses from this interviewee indicates that proposing suggestions that bypass their direct supervisor is deemed unacceptable in Case A. With limited support from the management, the proposal system is unlikely to be embedded.

Second, the proposal system only runs once a year, which is infrequent based on the criteria. This further demonstrates that it is not embedded.

Although the proposal system is open to all employees and provides a relatively good financial reward for high-quality suggestions, with the limited management support and infrequent suggestion collation, the proposal system in Case A (Central SOE, Auto) is considered as not being embedded. This is because employees have concerns about being penalised after proposing suggestions to high-level managers that would outweigh any motivation provided by the financial rewards.

4.2.1.2 Case B (Local SOE, Auto)

In Case B (Local SOE, Auto), the firm introduced their proposal system in around 2010 as part of the introduction of the Toyota Production System (TPS). They invested nearly 1 million RMB in hiring a professional management consulting company from Japan to design the TPS for them. For managing the proposal systems in Case B, they established a Product Creation Committee at company level that was specifically responsible for collecting, evaluating and implementing suggestions made by employees. This committee comprises permanent members of staff including the CEO, vice presidents and senior level engineers, along with temporary staff members including technological experts

from different departments, and experts from universities and other external organisations. Therefore, such a committee has both firm-specific and industry-specific expertise when evaluating suggestions from employees.

Their proposal system has two main parts, namely the Kaizen Idea Programme and the Kaizen Team Programme, both managed by a Product Creation Committee at company level.

The first part is called the Kaizen Idea Programme which collects work-related suggestions from all employees aiming to improve work efficiency by making incremental changes to the work processes.

The system was designed to allow employee participation in the system on a voluntary basis. However, the involvement of employees in this programme is very low because of a lack of a company-wide culture to encourage proposing suggestions to higher level managers, this is a similar problem to the one faced by Case A (Central SOE, Auto).

Thus, Case B (Local SOE, Auto) changed the system to a compulsory programme in 2011 that all employees, including managers, must propose a certain number of work-related suggestions to the Kaizen Idea Programme every year. This programme runs throughout the year so that employees could make their suggestions at any time. According to the vice president of Case B “... *everyone was asked to make five suggestions related to their job. ... Those suggestions will be proposed directly to our committee [Product Creation Committee] through our online system so that other managers cannot manipulate their subordinates in this [suggestion making].*” (B-VP)

Therefore, with a compulsory proposal system, the involvement of employees in making suggestions has improved dramatically. However, a compulsory system cannot guarantee

the quality of suggestion made by employees. Thus, Case B has introduced an incentive mechanism to reward good suggestions with greater financial rewards. High quality practical suggestions will be selected by the Product Creation Committee every year and awards varying from 2,000 to 5,000 RMB will be made to each good suggestion. The average salary of a shop floor worker in Case B is around 4000 RMB. Thus, the amount of financial reward is high enough to stimulate employees into making high-quality suggestions.

It has been noted by the Head of Production department that *“the quality of suggestion [Kaizen Idea] and projects [Kaizen Teams] has improved dramatically in last few years. I think it is because we have gradually developed a culture in our company that encourages them [the shop floor workers] to make suggestions and improve their work. ... I feel that proposing ideas to managers is very common among our workers now.”* (B-HoP)

The second part is the Kaizen Team Programme, which allows employees to form small project teams on a voluntary basis to solve any complex technological problems they choose. The Kaizen teams need to register their projects with the Product Creation Committee at first. After the committee has approved their projects, they are able to apply for resources and working hours to work on their projects. If the project successfully solves challenging technological problems, the company will reward them financially. The amount of reward ranges from 5,000 to 20,000 RMB to each team member. Furthermore, Case B allows the Kaizen teams to patent their outcomes privately. Then, the company will purchase the patents from the employees at market value. This mechanism allows employees to be fairly compensated if they develop innovative solutions to challenging technological problems. The phenomenon that the company

allows its employees to patent the outcome of problem-solving projects privately only occurs in Case B amongst all the cases involved in this research.

The proposal system in Case B (Local SOE, Auto) is embedded because the top management supports it, it runs all year long, it involves all employees, and it offers high financial rewards for high-quality suggestions.

4.2.1.3 Case C (Local SOE, Auto)

In Case C (Local SOE, Auto), the firm introduced their first proposal system in around 2012. Therefore, they have had similar problems as those faced by Case A (Central SOE, Auto) in terms of employees being reluctant to proffer suggestions due to concerns about being penalised by their direct supervisor. However, the poor performance of the old proposal system over nearly three years, has prompted them to form a long-term joint research programme in management studies with a local university, aiming to redesign their entire management structure, including the proposal system. This university is one of the leading universities in management studies in China. Based on QS (2017) World University Rankings by Subject, their management school is ranked 11th in China in 2017. Unfortunately, by the time the interviews were conducted, the new proposal system had yet to be launched. Therefore, the original proposal system will be discussed in this thesis.

The Kaizen Committee manages the current proposal system at company level. This committee is directly led by the CEO and comprises nearly all high-level managers of Case C and senior level engineers in their R&D department. In addition, two groups of experts are also often invited to join the committee temporarily to evaluate the quality and usefulness of the Kaizen suggestions and Kaizen projects. The first group of experts are professional experts from different departments in the firm. They have the firm-

specific knowledge and also professional knowledge so that they can evaluate the practicality of suggestion made by employees. The second group of experts are professors from local universities in different disciplines to provide more up-to-date knowledge on how to operationalise suggestions from employees. Therefore, such a committee has both firm-specific and industry-specific expertise.

The proposal system includes two programmes namely the Kaizen Suggestions and the Kaizen Projects. Employees take part in these two programmes on a voluntary basis. Firstly, employees are able to make suggestions to the Kaizen Suggestions programme and they will receive 5 RMB for each suggestion they make. The ten best suggestions will be selected every half year and are awarded 800 RMB each.

Secondly, if a group of employees want to solve a more challenging technological problem together, they can form a team and register with the Kaizen Projects programme to apply for resources and time from the Kaizen Committee to carry out their experiment. However, before they can be approved as a Kaizen project, the team has to produce some preliminary outcomes to be presented to the committee to justify the validity of their project. In other words, Kaizen teams need to invest personal time and money to produce some outcomes to convince the committee to recognise and formally register their works as Kaizen projects.

Successful projects are financially rewarded but the amount of reward varies dramatically according to the significance of the problem being solved. Moreover, no further financial rewards will be given even though the outcomes of some Kaizen projects are patentable innovations. Instead, the VP in Case C notes that in addition to money given to successful Kaizen teams by the company “...we also encourage our workers to apply for city level,

provincial level and even national level awards... (C-VP)". The company will provide help to their employees when they apply for such awards.

As opposed to the situation in Case B (Local SOE, Auto), Case C (Local SOE, Auto) specifically forbids Kaizen Project teams to patent their outcome privately, as noted by administration manager: "*... they [the Kaizen teams] cannot patent their outcome under their names because they have used the company's resources and working hours to work on their project... If outcomes from the Kaizen projects are patentable, our company must be the owner of those patents...*" (C-AM).

The embeddedness of the proposal system is questionable for two main reasons.

First, Case C (Local SOE, Auto) lacks supports from mid-level managers. Although Case C has a company level committee that manages the proposal system, which is very similar to the one in Case B (Local SOE, Auto), it seems that employees in Case C are simply reluctant to make suggestions in the first place.

According to the assistant of the Administration Manager in Case C, who has worked in the production department for one year as part of his job rotation: "*... if I was a skilled worker, I would not propose anything in Kaizen programme. ... It is not worth it to get that 800 RMB but upset your supervisors.... (C-AoAM)*".

The reflection by the assistant of the Administration Manager indicates that Case C may lack a culture among managers to appreciate their subordinates to report things to high-level managers, thus bypassing them. The consequences of doing so might lead to some sort of punishment. In addition, in the minds of the employees, the amount of the rewards received does not outweigh the punishment associated with upsetting their direct supervisors.

Secondly, the reward system of Case C is vaguely linked with the proposal system. The amount of financial reward for good suggestions is 800 RMB for each from a total of 20 good suggestions selected annually. However, the average monthly salary of a shop floor worker in Case C is around 2,000 – 3,000 RMB. Therefore, the 800 RMB seems not that attractive to the employees in Case C to propose high-quality suggestions. In addition, with gaining that 800 RMB, they run the risk of ruining the relationship with their direct supervisors.

Although their proposal system involves all employees and runs twice a year (relatively frequently), due to the two problems discussed above their proposal system would not work properly.

Therefore, taking into consideration the two problems linked with the proposal system in Case C, it is reasonable to conclude that their proposal system is not embedded.

4.2.1.4 Case D (Private, Auto)

In Case D, their case is quite different from all other cases as Case D is a private limited company. Their entire management system is nearly all designed by a mid-level manager, the Head of Quality Assurance Department (HoQC), who is very interested in modern management studies. He has not had any formal education or training in management courses. Instead, he learnt management theories and practices from reading books.

The proposal system used in Case D is entirely designed by the HoQC. Case D has a Kaizen Committee at company level led directly by the CEO. Moreover, all senior level managers are also members of this committee plus the HoQC who has designed the entire system. Apart from members of the committee, experienced workers and engineers are

often invited to join the committee temporarily when evaluating suggestions made by employees. The proposal system in Case D includes two programmes.

The first one is a Suggestions Scheme that asks employees to make work-related suggestions voluntarily. Each suggestion will be rewarded 5 RMB as a “... *symbolic reward*... (D-HoQC)”. The suggestions are evaluated every three months, and the best suggestion will be awarded 500 RMB.

The second one is a programme named Focus Topic. The company will publish a list of technological problems every year and allows technological experts to choose which to solve. The vast majority of these problems occur during production and are reported by first line managers. According to the Head of Production Department: “... *Those problems are not that difficult but required experienced worker and engineers to invest extra effort to work out the best solutions gradually. ...Successful projects will be rewarded financially to motivate them to participate [Focus Topic]. ... (D-HoP)*”. The amount of reward for successful individuals or teams in Focus Topic program is around 5000 RMB per individual or per team.

A Kaizen Committee manages both programmes at company level led directly by the CEO. Moreover, all senior level managers are also members of this committee. Apart from members of the committees, experienced workers and engineers are often invited to join the committee temporarily when evaluating suggestions made by employees. Although the setup of the Kaizen Committee is very similar to the Cases B and C (Local SOEs, Auto), Case D (Private, Auto) does not have access to invite external technological experts as their local university is very weak in engineering studies. Therefore, their committee has mainly firm-specific expertise.

The proposal system of Case D (Private, Auto) is considered as embedded. First, the proposal system in Case D is strongly supported by top management, involves all employees and runs all year long. Moreover, all suggestions are evaluated every three months, which is frequent enough for employees to receive rewards quickly and thus they remain motivated.

Second, the amount of financial reward for the Suggestion Scheme and Focus Topic is sufficient to motivate employees to participate. The average monthly salary of a shop floor worker in Case D is about 1500. The salary level is very low in comparison to that in other cases. This is because Case D is located in a poorly developed area in Eastern China, where the overall income level is also very low. 500 RMB for the best suggestions contributes significantly to the income of its employees. Moreover, a 5000 RMB reward for successful individuals and teams in Focus Topics is even more attractive to employees in Case D.

4.2.1.5 Case E (Central SOE, Railway)

In Case E (Central SOE, Railway), the firm started their proposal system in 2012 following an order issued by their parent company CRRC – the monopolistic firm that dominates the railway sector in China.

The earliest proposal used by Case E is labelled the Suggestion Scheme, which asks employees to make work-related suggestions to mid-level managers (the head of the department). The mid-level managers will report any good suggestions to the Lean Production Office at company level. This office is only an administrative office with three staff to organise suggestions handed in by mid-level managers and to finally report to high-level management meetings.

Employees receive 5 RMB for each suggestion they make to the Suggestion System. Moreover, the top ten suggestions will be selected by high-level management every year and gives 500 RMB to each of them. These are the only two types of rewards that employees are able to receive from taking part in the Suggestion Scheme.

In 2013, the proposal system was renamed as Gold Point without any change to its operation. In 2015, the proposal system was renamed as Five Small. This name comes from five categories of suggestions that the company expects to receive from employees, namely: “... *small improvement, small invention, small creation, small saving, and small suggestion* ... (E-VP)”. However, the operation of the proposal system still remains the same.

The proposal system in Case E (Central SOE, Railway) is considered as not embedded for three reasons.

Firstly, the top management support to the proposal system is not as high as in Case B (Local SOE, Auto) and Case D (Private, Auto). This is because the proposal system in Case E is managed by a small office at company level that does not have the authority to make any decisions. Their role is simply collecting suggestions and sending them over to mid-level managers, instead of top managers. Based on the criteria, this means the proposal system in Case E is not embedded.

Second, the proposal system in Case D is an event like a programme that only runs once a year and lasts only a month.

Secondly, the amount of financial reward given to the top ten suggestions does not seem sufficient to motivate employees to actively make suggestions. The average monthly salary of shop floor workers is about 2000 RMB in Case D. The 500 RMB, as the only

kind of reward to high-quality suggestions made by employees, seems insufficient based on those experiences in Cases B and C.

Therefore, although the proposal system in Case E involves all employees, the embeddedness of this system is still not embedded.

4.2.1.6 Case F (Central SOE, Railway)

In Case F (Central SOE, Railway), they introduced their proposal system called the Suggestion Scheme as an important part of their lean production practices in early 2015. By the time of the interview, the CEO was about to hold a meeting with all senior level managers to discuss the outcome of having lean production practices for a year. According to the CEO in Case F: “... *after one year of introducing lean production to our company, we saved nearly 600,000 RMB on raw materials and about 250,000 RMB on maintaining machinery and replacing accessories... based on suggestions from our employees...(F-CEO)*”.

The Suggestion Scheme of Case F is managed by a Lean Production Office lead by a VP at company level along with a few staff. This office is responsible for collecting suggestions directly from first-line employees. Suggestions collected will be anonymised by the office. Then, suggestions will be categorised based on their content and are sent to the department heads of the relevant departments for evaluation. With an anonymising mechanism, department heads would not know who has proposed the suggestions even though they are responsible for the evaluation stage.

Case F learnt this mechanism from a Japanese foreign direct investment (FDI) firm located close to them. In 2011, the CEO of Case F organised a visit to the Japanese FDI firm specifically to learn their experiences on managing lean production. Case F learnt

from the Japanese firm to anonymise the evaluation system to avoid any bias of mid-level managers when evaluating suggestions.

Employees will receive 5 RMB for every suggestion they make. All high-quality suggestions will be selected by the Lean Production Office every year and each will be awarded 500 RMB. It is found from interviews that Case F has very weak production capabilities as they inherited poorly trained workers from their parent company when they initially started. Therefore, the salary for shop floor workers was set very low, which is only around 1500 RMB a month. Thus, a 500 RMB reward could contribute significantly to the overall income of employees who actively make high-quality suggestions.

Therefore, although Case F (Central SOE, Railway) has just introduced their proposal system for a year, the proposal system is carefully designed incorporating the experience from the Japanese FDI firm to ensure the embeddedness of the system. Moreover, the rewarding system linked with the proposal system is also well designed to motivate employees to make suggestions.

The proposal system in Case F is considered as embedded. First, it is strongly supported by the top management because they have an office led by a vice president to manage the proposal system. Second, it involves all employees. Third, Case F rewards high quality suggestions with generous financial rewards.

Although it only runs once a year, it is considered as reasonable given that they only introduced the proposal system for about a year when the company was interviewed. Therefore, the proposal system in Case F is embedded.

4.2.1.7 Case G (Central SOE, Railway)

In Case G (Central SOE, Railway), they did not have a formal suggestion system as their organisational structure is significantly less hierarchical than all other cases studied. The CEO of Case G stated: “... *we have a very flat organisation structure. Everyone can simply come to my office if they want. They can discuss their suggestions with me directly. Or, they can tell their line manager and their line manager can come to me... (G-CEO)*”.

Moreover, Case G is only an assembly plant that does not produce anything in-house. The couplers of trains are not complex devices to assemble. The underlying technological difficulties are embedded in raw materials and production. In addition, they have only two types of products transference, so their assembly works are relatively straightforward and not labour intensive.

However, it was revealed during the interviews that with a flat organisational structure, employees in Case G make suggestions to high-level managers in two areas even though they do not have a formal proposal system. Firstly, assembly workers have made some improvements to the existing assembly tools based on their work experience. Moreover, they also invented a rotating platform to help them with holding different parts during assembly which dramatically increased their working efficiency. The Head of Assembly division states: “... *we used to spend 12 working hours to assemble one pair of train coupling systems... [However] we reduced this to 8 hours ... with our improved tools and rotating platform ... (G-HoA)*”.

Secondly, since Case G (Central SOE, Railway) does not have a production capability, they appoint experienced engineers from the R&D departments to work very closely and in person with their suppliers. Case G specialises in licensing and localising imported

technologies. They have a strong in-house R&D department focusing on improving imported technologies but outsource all production. Case G will send engineers to help suppliers solve technological production problems. However, if engineers learnt any new knowledge from their experienced suppliers, the engineers will report that new knowledge back to Case G to help their R&D department with improving the product design in the future. It is noted by Head of R&D department: “... *our engineers...help our supplier ... with their technological problems ... [however] some of our suppliers are very experienced, so our engineers have learnt a lot from them and report back to us [company]... [which] helps with future product development ... (G-HoR&D)*”.

Therefore, although Case G does not have a formal proposal system in place, their employees still make suggestions based on their work and interaction with suppliers to high-level managers. This is partly due to the flat organisation structure they have.

In addition, the CEO has also developed an environment where employees can freely propose suggestions to senior level managers. This environment also plays a major role in ensuring an informal proposal system works. It shows a high level of top management support to employees who propose suggestions. Thus, in this study, Case G will be considered as having an embedded proposal system even though they do not have a formal, dedicated proposal system.

4.2.1.8 Summary of proposal systems

Empirical evidence shows that although the central SASAC has instructed all SOEs to adopt proposal systems, SOEs design their proposal system differently. The proposal system in the private firm also differs from what SOEs have. The difference in the operational detail embeds some proposal systems, while others do not.

Moreover, empirical evidence shows that embedded proposal systems share four characteristics. First, embedded proposal systems are strongly supported by top management of the firms. It allows firms to implement good suggestions and motivates employees to make suggestions. Second, embedded proposal systems involve all employees. Third, embedded proposal systems run frequently every year. Finally, embedded proposal systems generously reward high-quality suggestions.

In addition, Table 4-2 summarises the proposal systems in all cases and is accompanied by typical quotes from interviewees.

Table 4-2: Summary of proposal system practices in all cases and representative quotes

Proposal System		
Company	Practices	Quotes
A	Suggestion Scheme for individuals	“We have our Suggestion Scheme to collect suggestions from our employees. Suggestions could be related to the product, production and also management. We pay 5 yuan for each suggestion. Every year we will select the 5 best suggestions and give them awards”. (A-CE)
B	Kaizen Idea Programme Kaizen Team Programme	“We have two different Kaizen programmes, but all are supervised by our Product Creation Committee. We have the Kaizen Idea programme to gather suggestions from all employees ... [all employees] are asked to propose five suggestions related to their job. ... Our Kaizen Team programme is designed to allow workers who share the same interests in certain problems to form a team. ...targeting more complex and challenging problems.” (B-VP)
C	Kaizen programme for individuals and teams	“We have the Kaizen programme every half year. Employees can form teams or work alone to work on their new ideas. Their achievement will be evaluated by our committee every half year and will select the top ten Kaizen suggestions [for rewarding].” (C-VP)
D	Kaizen Programme Focus Topic	“... we have the Kaizen programme and the Focus Topic programme. We have the Kaizen programme every three months. We formed a Kaizen committee composed of high-level managers and department directors, as well as some experienced senior engineers. ... Focus

		Topic programme ... allows employees to solve the problems we listed each year. [Employees] choose any topic and use company resources to solve it.” (D-HoQC)
E	Kaizen events since 2012 last around one month every year (Renamed as Gold Point in 2013, refined and renamed as Five Small Ideas in 2015)	“After we introduced Kaizen in 2012, we have had many company events that ask for suggestions from employees. We started a project called “ Gold ideas ” from 2013. This aims to allow employees to propose their suggestions regarding production processes, health & safety, waste elimination, and so on. ... In 2015, we further clarified what we expect from our employees by giving them 5 categories of Kaizen suggestions. It is called “ Five Small Ideas ” including small improvement, small invention, small creation, small saving, and small suggestion. This classification includes suggestions about the products, production processes and managerial flaws.” (E-VP)
F	Proposal System	“We have a proposal system for employees to submit suggestions directly to high-level management. ... They can suggest anything related to their work.” (F-CEO)
G	Informal proposal system due to flat organisational structure	“... we have a very flat organisation structure. Everyone can simply come to my office if they want. They can discuss their suggestions with me directly. Alternatively, they can tell their line manager and the line manager can come to me.” (G-CEO) “They can even go to the CEO’s office directly because all of our employees have a very good personal relationship.” (G-HoR&D) “If they have suggestions about products, they can tell them to our director of the R&D department, or tell our CEO directly.” (G-HoA)

Finally, an illustrative table is produced to clearly display the empirical findings (See Table 4-3) showing which cases have adopted a proposal system, and whether or not it is embedded.

Table 4-3: Summary of findings on proposal system practices in firms and its effectiveness

Case \ BUL Practices	Proposal System
A	■ ○
B	■ ●
C	■ ○
D	■ ●
E	■ ○
F	■ ●
G	■ ●

- Has the BUL practice
- BUL practice is embedded
- Do not have the BUL practice
- BUL practice is absent or not embedded

4.2.2 Problem-solving mechanisms

Problem-solving mechanisms aim to solve technological problems at the different levels of the firm in systematic ways to effectively learn from problems (Marksberry *et al.*, 2011; Tjosvold *et al.*, 2004; Simon, 2012).

The problem-solving mechanism adopted by the seven cases studied will be analysed in the following sub-sections.

In commercial vehicle sectors, ISO/TS 16949 is a technical standard that all firms need to follow and will be certified against if they want to become suppliers to major car manufacturers like Ford, Toyota, Volkswagen, and so on. It is designed by the world's leading automobile manufactures together to ensure the competence of their OEM suppliers. ISO/TS 16949 specifically requires certified firms to have a formal problem-solving mechanism to solve production and quality problems.

In the railway equipment sector, the international standard is called the International Railway Industry Standard (IRIS). To produce railway equipment and become a supplier

to train manufacturers, a firm must be certified by IRIS. The IRIS standard also has a specific requirement for firms to have formal problem-solving mechanisms to solve production and quality problems.

In this research, Cases B, C and D all have parts of their business supplying the main automobile manufactures. Therefore, they have all been certified according to ISO/TS 16949. Case A does not supply to major automotive manufactures, so they do not follow ISO/TS 16949.

Similarly, all cases in the railway equipment sector including Cases E, F and G are certified by IRIS.

Such international quality standards impose top-down instructions on firms to have problem-solving mechanisms. However, both ISO/TS 16949 and IRIS do not specify what problem-solving mechanisms should be adopted. Therefore, these seven cases have designed their problem-solving mechanisms differently. Such differences could also embed some problem-solving mechanisms, while others do not.

Therefore, the level of embeddedness of problem-solving mechanisms in all seven cases will be evaluated in the following sub-sections. The criteria of embedded problem-solving mechanisms are developed from the literature and summarised in Table 4-4

Table 4-4: Criteria for embedded and not embedded problem-solving mechanism

Embedded	Not embedded
Team-based	Individual-based
Defined and structured process	Undefined and unstructured process

4.2.2.1 Case A (Central SOE, Auto)

Case A only produces diesel engines, so it does not need to comply with TS 16949. Its products are primarily used by the defence sector, so it has another standard to follow. Case A is certified by a standard devised by the PLA General Armament Department, which is not available to the author. Therefore, it is not clear whether the standard requires firms to have a defined problem-solving mechanism or not, like those required in ISO/TS16949.

The problem-solving mechanism in Case A divides technological problems into two types. The first type is simple problems occurring in daily productions. It is the responsibility of low-level engineers – technologists on the shop floor, to work out solutions. Technologists will work with employees to collectively solve any simple problems that arise. The problem-solving activities on the shop floor are supervised by line managers.

The second type of problems is where they are too complex and challenging to be solved merely by workers and technologists on the shop floor. These problems emerge mainly from R&D projects and producing prototypes. Moreover, major quality defects reported by customers are another source of complex problems.

This type of problem is solved by project teams comprising experts from different fields. The members of such problem-solving teams are temporarily appointed by high-level management. They will return to their original position after the problem has been solved.

Since complex problems involve a high level of investment in time and resources, problem-solving teams will be led by one or two senior level managers at vice president level. Although senior managers do not usually become involved in actual problem-

solving activities, they will give the problem-solving team sufficient authority to make decisions quickly when needed.

The problem-solving mechanism in Case A (Central SOE, Auto) is considered as embedded because it relies on multi-disciplinary problem-solving teams at company level to solve challenging technical problems.

As mentioned in the introduction, ISO/TS 16949 is an industrial standard devised collectively by the world's leading car manufacturers to certify their suppliers. This standard has an instructive top-down influence on making firms in the automobile sector have a defined problem-solving process.

ISO/TS 16949 states that “the organisation shall have a defined process for problem-solving leading to root cause identification and elimination” (ISO/TS 16949, 2002: 32).

Therefore, Cases B, C and D have to have a formal and defined process to solve problems. However, because the standard does not specify what method to use for problem-solving, the design of the problem-solving mechanism varies amongst them. As does the embeddedness of their problem-solving mechanism.

4.2.2.2 Case B (Local SOE, Auto)

In Case B (Local SOE, Auto), the entire problem-solving mechanism is based on the Eight Disciplines Problem-solving Method¹ (8D method) developed by the Ford Motor Company. The 8D method is primarily used to develop long-term solutions to

¹ Eight Disciplines Problem-solving (8D) method was developed by Ford Motor Company based on PDCA (plan, do, check, act) logic. “**D0**: Plan; **D1**: Use a team; **D2**: Define and describe the problem; **D3**: Develop interim containment plan; implement and verify interim actions; **D4**: Determine, identify, and verify root causes and escape points; **D5**: Choose and verify permanent corrections (PCs) for problem/nonconformity; **D6**: Implement and validate corrective actions; **D7**: Take preventive measures; **D8**: Congratulate your team” (See details in Duffy, 2014: 119-120).

technological problems(Duffy, 2014). Case B uses this method extensively as they require all employees to follow this 8D method when solving technological problems at the company level, at the department level, and at shop floor level.

The second discipline of the 8D method is to form a problem-solving team comprising experts from different disciplines (Duffy, 2014). Therefore, Case B relies heavily on multi-disciplinary teams to solve technological problems.

In Case B (Local SOE, Auto), simple technological problems are solved by quality circles (QCs) at shop floor level. Each quality circle comprises a few engineers and workers from each production division. The members of the quality circles are relatively stable so that they can constantly work together to solve problems.

If certain problems are beyond the competence of the QCs at shop floor level to solve, department heads will ask experts in their department to form teams to tackle those problems by forming temporary problem-solving teams using the 8D method.

Problems that require a joint effort from different departments will be solved by teams at company level. These teams will be led by senior-level managers to give them the authority to allocate resources and autonomy in making decisions. The problem-solving teams at company level are also temporarily formed so members of the teams will return to their position after the project is accomplished.

To sum up, Case B relies on permanent QCs to solve daily technological problems, and temporary problem-solving teams at department and company level solve problems that are more complicated and challenging. All of the problem-solving teams in Case B need to follow the 8D method to solve problems systematically.

The problem-solving mechanism in Case B (Local SOE, Auto) is embedded for two reasons. First, it is largely based on multi-disciplinary teams to solve technological problems. Second, it adopts the 8D problem-solving method as a structured problem-solving mechanism to develop long-term solutions to problems.

Moreover, the use of temporary multi-disciplinary problem-solving teams encourages BUL because team members can share tacit knowledge by working collectively. After they return to their original position, they can take the new tacit knowledge with them and share with other colleagues.

4.2.2.3 Case C (Local SOE, Auto)

In Case C (Local SOE, Auto), the problem-solving mechanism is also extensively based on the 8D method of problem-solving. Their system is very similar to the one used in Case B (Local SOE, Auto).

However, Case C does not rely merely on quality circles to solve technological problems. Instead, supervisors in the production divisions in Case C will appoint temporary problem-solving teams comprising workers and engineers with different expertise at shop floor level to address any technological problems that are relatively simple to resolve. Quality circles in Case C are mainly responsible for improving production efficiency and product quality through slowly modifying production processes.

Problem-solving teams at the department and company levels are very similar to the set up in Case B (Local SOE, Auto).

Case C also forms temporary multi-disciplinary teams to solve problems at company level and departmental levels. All members of the teams will return to their original posts once the issue is resolved.

Therefore, Case C (Local SOE, Auto) has an embedded problem-solving mechanism using multi-disciplinary teams. In addition, the mechanism is structured based on the 8D method.

As mentioned above, the use of temporary multi-disciplinary problem-solving teams encourages BUL by allowing members of the problem-solving teams take newly developed tacit knowledge back to their original post to share it with their colleagues. This helps the dissemination of tacit knowledge across the organisation. Cases B and C matches with the description of a typical J-form organisation identified by Lam (2002; Lam, 2005).

4.2.2.4 Case D (Private, Auto)

In Case D (Private, Auto), although they need to comply with the ISO/TS 16949 standard, they do not use the 8D method. Instead, they use PDCA² (plan, do, check and act) approach developed by Deming (1950) to improve product quality and resolve technological problems.

Case D relies on quality circles (QCs) to solve daily technological problems occurring in production. The members of QCs are workers and engineers at shop floor level. They will try to solve technological problems on a daily basis. Because the members of the QCs are stable, they can easily share tacit knowledge through daily interaction.

The technological problems that emerge during R&D and producing new products are specifically dealt with by temporary problem-solving teams at company level led by senior-level managers. Moreover, problems occurring in daily production but beyond the

² PDCA, also known as Deming Cycle, is a systematic approach including four steps, namely plan, do, check and act, for learning and knowledge development to continually improve products or processes. (See detail in <https://deming.org/management-system/pdsacycle>).

capability of the QCs to solve will also be dealt with by the problem-solving teams. Problem-solving teams are experts from different departments summoned directly by senior-level managers. After the problem is solved, they will return to their original positions.

Furthermore, Case D also has another system for solving technological problems with high involvement of experts at shop floor level called Focus Topic, which has been discussed previously in Section 4.2.1.4 on page 143.

The company will list some technological problems that need to be solved every year. Employees can form project teams voluntarily to solve the one they choose using company resources. The company will generously reward successful teams. This system is a problem-solving mechanism to allow employees to voluntarily solve problems.

In conclusion, Case D has a structured problem-solving mechanism based on the PDCA approach using permanent QCs at shop floor level and temporary multi-disciplinary teams at company level. Moreover, they have another problem-solving system to encourage employees to solve technological problems on a voluntary basis. Therefore, the problem-solving mechanism in Case D (Private, Auto) is considered as embedded.

As mentioned early in Section 4.2.2, firms in the railway equipment sector need to be certified by the IRIS. The IRIS standard also specifically requires firms to have formal problem-solving mechanisms to solve production and quality problems, like ISO/T 16949 for the automobile sector.

Therefore, such international standards impose an instructive and top-down influence on making Cases E, F and G (Central SOEs, Railway) to have structured problem-solving mechanisms to address technological problems.

4.2.2.5 Case E (Central SOE, Railway)

In Case E (Central SOE, Railway), the problem-solving mechanism is to form problem-solving projects with multi-disciplinary teams at the different levels of the firm.

All of the problem-solving projects are formed temporarily at company, departmental and shop floor levels respectively. In addition, Case E has a reporting system that allows problems being reported to, and being dealt with, at higher levels. For example, problems that cannot be solved by a team at shop floor level will be passed to a project team at the department level. Consequently, the most complex and challenging problems will be solved by project teams at the company level.

The members of those project teams are not fixed. Therefore, they will return to their original position after the project is accomplished. Moreover, the project team at company level will be led by senior-level managers to give the project team the authority to make decisions effectively.

The problem-solving mechanism in Case E (Central SOE, Railway) is considered as embedded because they use multi-disciplinary problem-solving teams at all levels of the firm. Moreover, their mechanism is structured based on a systematic reporting system to address problems at different levels of the firm.

4.2.2.6 Case F (Central SOE, Railway)

In Case F (Central SOE, Railway), the problem-solving mechanism is also to form problem-solving projects at the different levels of the firm, similar to those in Case E (Central SOE, Railway).

They have temporary problem-solving teams at company level to solve difficult and challenging problems, and at department level and shop floor level to solve simpler problems.

However, the CEO states: “... *we have ... low production capability. We have to outsource most of our difficult parts to third parties...* (F-CEO).” Case D does not have well trained and experienced production workers at shop floor level. Thus, the problem-solving capability of their worker is significantly limited.

Interestingly, due to the fact that Case D outsources all complex parts to their suppliers, Case D developed close relationships with local suppliers forming a joint problem-solving mechanism. Engineers in the R&D departments are divided into project teams according to the type of parts they outsource. Each product team will frequently visit local suppliers in person to solve product design and production problems. Within this joint problem-solving mechanism, Case F provides product design knowledge to local suppliers, at the same time, local suppliers provide practical production knowledge to employees from Case F. Such practical production knowledge could finally be transferred to the production department in Case F to gradually improve their production capability.

To sum up, Case F has an internal problem-solving mechanism based on temporary problem-solving projects at different levels of the firm. Furthermore, they have an external problem-solving mechanism based on joint problem-solving activities with local suppliers that are similar to the multi-disciplinary problem-solving teams. What is more, the external system complements the weak problem-solving capability in the production department of Case F, and acts as a source of production knowledge to improve internal production capabilities. Therefore, Case F has an embedded problem-solving mechanism.

4.2.2.7 Case G (Central SOE, Railway)

In Case G, because the firm does not have any in-house manufacturing capability at all, they do not face production problems.

Their first issue is that of technological problems that emerge during R&D activities. Case G produces two models of couplers, thus their R&D department has two R&D divisions responsible for each respectively. Under each R&D division, they will form small project teams to solve problems in modifying the product design based on feedback from two main sources, namely their suppliers and users. Firstly, Case G has very close interaction with its suppliers to transform product design into practical production manuals. During this process, engineers from Case G will collect and analyse suggestions from suppliers to modify product design to reduce any complexity in the production process, which will eventually reduce the overall cost. Secondly, Case G provides regular maintenance of their products for customers. Therefore, product maintenance teams will collect feedback from users, and will report them to the R&D department for product improvements.

Their second type of problem emerges from the product assembly process. Case G is short-staffed in its assembly department, therefore, they need to develop customised tools and procedures to improve the efficiency of the production process. The staff in the assembly department in Case G are all very experienced workers who have transferred from the parent company, thus they have developed many specialised tools based on their working experiences from their previous roles.

In conclusion, Case G has an embedded problem-solving mechanism based on joint technological problem-solving with supplier and end users that resemble multi-disciplinary problem-solving teams.

4.2.2.8 Summary of problem-solving mechanisms

From analysis of the data relating to problem-solving mechanisms implemented in all cases in this research, a few findings can be revealed.

Firstly, all cases have problem-solving mechanisms that are highly embedded. As suggested in the literature, the main tasks of firms in the engineering and manufacturing sectors are to solve technological problems occurring in their daily operation. Therefore, those firms should have problem-solving mechanisms in place in order to survive in the market. In addition, all of the cases selected for this study are market leaders in their fields. It is reasonable to believe that they all have some kind of expertise, at least in technological problem-solving.

In addition, Cases B, C (Local SOEs, Auto) and D (Private, Auto) have to obey the laws pertaining to the industrial technical specification (ISO/TS 16949) which explicitly requires them to have problem-solving mechanisms using temporary multidisciplinary problem-solving teams to solve technological problems. Therefore, the TS 16949 could be part of an explanation as to why these three cases have implemented problem-solving mechanisms. Similarly, Cases E, F and G (Central SOEs, Railway) are also compelled by IRIS to have structured problem-solving mechanisms in place.

Secondly, although all cases have problem-solving mechanisms, the operational details of the mechanisms differ in terms of whether permanent, or temporary, or both problem-solving teams are used;

Thirdly, it is shown from the data that Cases F and G (Central SOEs, Railway) rely heavily on suppliers to solve technological problems in production as they have little (Case F) or no (Case G) internal production capability. Therefore, such joint technological

problem-solving mechanisms could be called external problem-solving mechanisms. These are quite different from the internal problem-solving mechanisms, which rely on employees within the firms to solve technological problems.

Table 4-5 summarises the problem-solving mechanisms in all cases and is accompanied by typical quotes from interviewees.

Table 4-5: Summary of problem-solving mechanism practices in all cases

Problem-solving mechanism		
Company	Practices	Quotes
A	<p>Low level engineers and workers to solve small problems</p> <p>Temporary problem-solving teams comprised of experts for large problems</p>	<p>“For small problems, they are expected to be solved at department level by the workers and low-level engineers. However, if we have big problems we will form a team to solve them at company level” (A-BM)</p> <p>“For large and challenging problems, we will form a group of experts to discuss and find solutions. ... This kind of arrangement is often generated by high level management.” (A-CE)</p>
B	<p>Problem-solving teams at all levels of firm using Eight Disciplines Problem-solving (8D) method</p> <p>Expert teams within company for major problem</p> <p>TQM teams for daily problem at shop floor level</p> <p>Kaizen Teams for voluntary problem-solving at work</p>	<p>“We will form teams to solve problems at different levels. We basically follow the 8D method of problem-solving. The first principle under the 8D method is to form a problem-solving team. Small problems will be solved at department level or by TQM teams. If we face a big problem ... we will form a high-level problem-solving team composed of experts in the relevant area and led by at least a VP or anyone having equivalent levels of power. In addition, we also have the Kaizen Teams who form teams voluntarily amongst workers to solve problem they have identified.” (B-VP)</p>
C	<p>Multi-disciplinary problem-solving team using the 8D method at different levels of the firm</p>	<p>“We have a well-established system following the 8D problems solving process. We will first form a specialised team composed of experts in different fields and tackle the problem from different angles.” (C-VP)</p> <p>“This procedure [8D method] is an important part of employee training. Because this procedure is very versatile, we use it at different levels of our company.” (C-PS)</p>
D	<p>Expert team to solve major problem</p>	<p>“At company level we have an expert team ... [comprising] mainly experienced workers and engineers ... led by a high level manager</p>

	<p>QC team solve small problem at shop floor level</p> <p>Focus Point to ask for solutions on specific technological problems from employees</p>	<p>because coordination resources across departments are often needed. ... This kind of team is mainly used for dealing with major quality issues. ... small problems will be solved by our QC teams at shop floor level.” (D-CEO)</p> <p>“...we also have an annual programme to ask employees to solve problems together. This is a competition style event ... called Focus Topic ... runs every year. At the initial stage we will list a group of problems we want to resolve and allow workers to provide solutions.” (D-VP)</p>
E	<p>Problem-solving projects at different levels of the firm</p> <p>Expert team will take difficult and challenging projects at company level</p> <p>Team formed by cadres with expertise to solve problems at shop floor level</p>	<p>“we have three levels of projects targeting solving technical problems. First ... the company level project, which is usually led by the R&D department to develop new products or solve difficult quality problems with existing products. Secondly, we have factory level projects, which are mainly production problems caused by obsolete machinery. We also have production division level projects, which mainly solve small production problems Managers at each level will be responsible to find appropriate specialists to form a team and work out solutions.” (E-CE)</p> <p>“We mainly use project based methods to solve ... problems that are difficult and challenging. ... We have ... [an expert team] at company level. Team members are usually engineers from our R&D department plus experts from factories. ... Each factory will have some cadres who are highly skilled in a certain field. Those people will be gathered by factory manager or production division supervisors to take on projects [at shop floor level].” (E-VP)</p>
F	<p>Project teams in R&D department responsible for different technological projects</p> <p>Joint R&D with CARS</p>	<p>“[Technological problem] are mainly solved by our R&D team. Because we only have simple parts in our factory, they do not often have technical problems. When we have a new product, we will try to ask our factory to produce all of them. If they have very high rejection rate with some parts, we will outsource them directly. This is why our factory is very small.” (F-CEO)</p> <p>“We have many project teams in our R&D department. Each of them will be responsible to solve some problems ... [work in] collaboration with universities and the China</p>

		Academy of Railway Science (CARS). ... [Project teams have] engineers come from various disciplines ... because the pantographs involve many different technologies.” (F-CE)
G	<p>Joint problem-solving with local supplier</p> <p>Solve problems identified by users by project teams at R&D department</p>	<p>“... technological problems are found by our suppliers. ... The engineer who is responsible to monitor that supplier will visit their factory and solve their problem together.” (G-CEO)</p> <p>“If our users identify any problem, we will form a project team in our R&D department to solve it for them.” (G-HoR&D)</p>

Table 4-6: Summary of findings on technological problem-solving mechanism practices in firms and its effectiveness

Company \ BUL Practices	Technological Problem-solving Mechanism
A	■ ●
B	■ ●
C	■ ●
D	■ ●
E	■ ●
F	■ ●
G	■ ●

■ Has the BUL practice

● BUL practice is embedded

□ Do not have the BUL practice

○ BUL practice is absent or not embedded

Finally, an illustrative table is produced to clearly display the empirical findings (See Table 4-6) showing which cases have adopted problem-solving mechanisms, and whether or not they are embedded.

4.2.3 Work-related record keeping

The work-related record keeping system for documenting problem-solving activities is a key knowledge management strategy. This helps to articulate tacit knowledge that is developed during the problem-solving process. However, records need to be regularly

reviewed by managers identifying good practices related to improving the production process and product design.

The level of embeddedness of work-related record keeping systems in all seven cases will be evaluated in the following sub-sections. The criteria of having an embedded record keeping system is developed from the literature and summarised in Table 4-7.

Table 4-7: Criteria for embedded and not embedded work-related record keeping systems

Embedded	Not embedded
Based on groupware or Office Automation (OA) software	Paper based, not integrated into office systems
Regularly reviewed by managers	Not or rarely reviewed by managers

4.2.3.1 Case A (Central SOE, Auto)

In Case A (Central SOE, Auto), workers in the production department are required to produce production records for quality assurance purposes. According to the VP of Case A: “... those documents are mainly used to meet the requirements of quality assurance systems like ISO 9001 etc.” (A-VP). Thus, the work records are infrequently reviewed by high level managers to identify good practices.

Moreover, their system is paper based so that workers could only use text to describe any problems.

Therefore, the work-related record keeping system is not embedded in Case A.

4.2.3.2 Case B (Local SOE, Auto)

In Case B, they have a designated online working records management system that is highly integrated with their office automation (OA) system designed by IBM. Employees of all positions are required to keep work records using templates provided online.

Production workers are required to keep detailed production logbooks including any problems encountered. The online system allows them to use not only text, but also pictures and videos to describe problems. For problem-solving activities at all levels of the company, they need to complete 8D problem-solving reports to record the problem-solving process in detail.

Moreover, all working records, especially records produced by production workers and engineers in the R&D departments are regularly reviewed by their department heads to find useful practices that could be adopted as routine.

Therefore, Case B (Local SOE, Auto) has an embedded record keeping system to manage work-related records and makes use of them to improve future works.

4.2.3.3 Case C (Local SOE, Auto)

In Case C, the company has an online OA system including a function to allow employees to fill in work-related records developed by a domestic OA company. The system must be completed daily by the production workers who note down any problems they find. Problems can be described using text, pictures and videos. If a problem is simple and could be solved quickly on site, workers are required to write down the problem-solving process along with proposed solutions. For problem-solving teams, they need to produce problem-solving reports using the 8D problem-solving method.

All of those records will be reviewed by their supervisors to identify good practice to share among other workers. Therefore, Case C (Local SOE, Auto) has a strongly embedded work-related record keeping system.

4.2.3.4 Case D (Private, Auto)

In Case D, the company has developed its own OA system based on the MS Office software and QQ (a Chinese online chat software) by the Department of Quality Control due to a shortage of funds. They could not afford to buy any customised OA software so they decided to develop one themselves. Case D hired two university graduates specifically for designing and managing this system. The local government has issued a city level award to Case D for “Innovation in office software”. When this system was introduced, the company faced high levels of resistance from the managers and workers due to their lack of knowledge in using MS Office packages. Therefore, Case D organised some internal training courses on using MS Office for the entire workforce. After training, the managers and workers could confidently use the system.

The system makes use of several pre-designed Word and Excel templates. Workers and managers in different departments need to fill in those files relevant to them. For example, production workers can note down problems encountered at work with text and pictures and insert them into Word files. Files produced by shop floor workers will be sent to department heads through QQ. Those files will be summarised by department heads and will then be presented at company level meetings.

Although Case D does not have a professional OA software to manage work-related work records, it is noted by the Head of the Quality Control department that: “...*the system we designed is highly customised to suit our needs... [which] normally would be very expensive ... Moreover, we can easily add new functions ...* (D-HoQC)”.

Moreover, the work records submitted to the department head will be reviewed, summarised and presented at weekly departmental meetings, and monthly company level

meetings. Therefore, department heads need to review those records regularly to produce the reports needed for those meetings.

Therefore, Case D (Private, Auto) has an embedded work-related, record keeping system.

4.2.3.5 Case E (Central SOEs, Railway)

In Case E, workers and engineers in problem-solving projects are particularly required to write very detailed reports because “...*managers will not always be part of the problem-solving process, the reports will be a main way to present their achievements to the relevant managers... (E-VP)*”. Case E does not have a designated OA system to manage those reports so those reports are all hard copies.

Apart from reports produced by problem-solving teams at different levels, other work-related reports are not regularly reviewed by department heads as they are submitted to the HR department to act as evidence of employees’ working hours.

Therefore, the work-related record keeping system in Case E (Central SOE, Railway) is not embedded.

4.2.3.6 Case F (Central SOE, Railway)

In Case F, the work-related records are not required. Only specialised problem-solving teams are asked to write detailed reports on problems solving. It is necessary as managers at higher levels need to make decisions based on such reports to make changes.

Moreover, Case F does not have an OA system. Therefore, the employees need to print out their reports and hand in them in, in person, to the relevant office.

Therefore, the work-related, record keeping system is not embedded in Case F.

4.2.3.7 Case G (Central SOE, Railway)

In Case G, work-related reports are specifically required for quality control. Since a train coupler is a vital part for the safe operation of trains, all of their products are checked individually by the Quality Control Department. Moreover, detailed reports are issued to every train coupler.

Moreover, engineers who work closely with suppliers in technological problem-solving are required to produce detailed reports if the product design has been modified based on feedback from suppliers. These reports need to be approved by high level managers before changes can finally be made. However, this kind of case is very rare according to the CEO of Case G.

Moreover, all of these records are paper based. Case G does not have an OA system.

Although Case G has a work record keeping system for quality control and joint problem-solving with suppliers, the embeddedness of this system is considerably weak. This is because the system is mainly used for quality control rather than knowledge management. Even though detailed reports are produced in joint problem-solving activities, the frequency of such activities is too low to be considered as an important construct of a work-related, record keeping system.

To conclude, the work record keeping system in Case G is not embedded.

4.2.3.8 Summary of work-related record keeping

From analysis of the data related to work-related, record keeping in those cases studied, a few findings are revealed.

Firstly, all firms have a work-related, record keeping system to collect and manage work-related records. Some of them (Cases E, F and G, central SOEs, railway) have it merely for quality assurance purposes. However, others (Cases B, C and D, local SOEs and private firms, auto) use the work-related records deliberately to establish good practice at shop floor level.

Secondly, record management systems used among these cases differ significantly. Local SOEs have invested huge amounts of money to hire specialised IT companies to develop customised OA systems to collect and manage work-related records from shop floor workers. Private firms (Case D, private, auto) can only afford to use widely available, generic office software to develop an OA system for themselves. Conversely, central SOEs studied in this research have invested little in work record keeping systems. Most of their work records are still paper based and lack a unified system to manage those records.

Table 4-8 summarises the work-related record keeping system in all cases and is accompanied by typical quotes from interviewees.

Table 4-8: Summary of work-related record keeping practices in all cases and effective evaluation

Work-related record keeping		
Company	Practices	Quotes
A	<p>Reports of problem-solving projects at company level</p> <p>Production logbook for QC purpose</p>	<p>“Workers and engineers are not expected to keep logs unless their line managers want them to.” (A-BM)</p> <p>“We do not have company level policies that tell our employees to keep a logbook. However, the departmental head often asks their team leaders to keep a log especially in the production department where re-traceable documentation is needed for quality control purposes. For our problem-solving activities at company level, the team leader needs to produce a report to report what has happened,</p>

		who is responsible for the problem and how it is solved. ... those documents are mainly used to meet the requirements of the quality assurance systems like ISO 9001 etc.” (A-VP)
B	<p>Online system to ask all employees to fill in work-related reports using various forms of data (text, picture, video)</p> <p>In-depth reports are required for problem-solving projects and Kaizen programmes</p>	<p>“... we have an online system to let all of our employees fill in notes related to their job. ... they can fill in a report that describes the problem. ... they can take a picture ... take a short video of the area they think is having problems. ... For problem-solving, they will need to fill in reports in more detail than in normal works. Especially for the Kaizen Teams, they need to fill in detailed reports in order to apply for resources from our Product Creation Committee. They will also need to provide a final report about the whole project and how their outcome can be implemented. This will be used to assess how each team is awarded financially.” (B-VP)</p> <p>“... workers are required to complete daily reports about their work. ... If production went smoothly ... they can keep this report simple. However, once problems emerge, they will need to note them down ... Otherwise, they will liable for the consequences of hiding production problems. If the problem is too complex ... they can use photos and videos to show what went wrong.” (B-HoP)</p>
C	<p>Daily work report by all employees using online system</p> <p>Problem-solving reports produced by problem-solving teams at different levels of the firm using online system</p>	<p>“... we have an online system that everyone needs to fill in with any necessary information at the end of every day. ... Problem-solving teams need to write very detailed reports about the problem-solving process according to those 8 disciplines [8D problem-solving method]. Keeping these records are clearly required in ISO/TS 16949. (C-VP)</p> <p>“[Problem-solving teams] need to hand in detailed reports to describe the problem, analysis of the problem and justification as to why a certain solution has solved it. If this report is approved by the production department, the solution they used may become part of routine to avoid the same problem in the future.” (C-AM)</p>
D	Regular work records produced by all employees	We ask our managers in the production department to produce a production log every day to keep good records for future reference and also for quality assurance. ... other

	<p>Detailed problem-solving reports</p> <p>OI system developed through DIY based on MS Office software (awarded by government for managerial innovation)</p>	<p>departments have similar things [records] too. ... (D-CEO)</p> <p>Our department have designed basically all templates for reports, daily logbook, meeting notes and so on. ... All those individual documents are Word files that most people know how to use. ... the template for summarising the report is produced with Excel. Managers are required to use hyperlinks in this Excel template to make it easy to navigate. ... we used to have problems when different managers do not how to use the system I developed, especially the hyperlink part. Therefore, I have organised many lessons to train them how to use the system we developed using MS Office software ... now they can use them very competently. ... we even received a city level award for Secondary Innovation in MS Office Software. This saved us a lot of money ... and is also more tailored to our needs. (D-HoQC)</p>
E	<p>Regular work reports by workers and engineers</p> <p>Problem-solving project report</p>	<p>“Engineers and workers need to write reports to summarise their works. This is an important mechanism for human resource management. For problem-solving projects, they will need to produce detailed reports. Because managers will not always be part of their problem-solving process, the reports will be a main way to present their achievement to relevant managers.” (E-VP)</p> <p>“company level projects are required to produce very detailed reports about each step in problem-solving and explain how solutions are developed. ... other two levels [department level and shop floor level] of projects will be the same. They also need to report to managers at different levels respectively” (E-CE)</p>
F	<p>Project reports by engineers in R&D department</p> <p>Production logbook by workers</p>	<p>“They [engineers] are required to produce very detailed reports of how each project is completed. This is used to apply for awards from CRRC for the annual competition in innovation.” (F-CEO)</p> <p>“...project team will need to produce a detailed report...” (F-CE)</p> <p>“[Production workers] will write production logbook before they go home. They mainly just note down amount of work finished. ... In terms of solving problems, we do not ask them</p>

		[workers] to produce a separate report unless the problem is caused by a worker’s mistake.” (F-HoP)
G	Reports of change on product design	<p>“All of our workers need to write work records. This is required for quality control. ... our quality department will also produce a final quality check report before they transport parts to the assembly factory. Our assembly worker also needs to fill in the work report to record their progress” (G-CEO)</p> <p>“If those problems require modification on our product design, our engineers will need to produce formal reports to record every change they make and explain why. ... [Requires] a series of testing and approval by our high-level managers...” (G-HoR&D)</p>

Finally, an illustrative table is produced to display the empirical findings clearly (See Table 4-9) showing which cases have adopted a work-related record keeping system, and whether or not it is embedded.

Table 4-9: summary of findings on work-related record keeping practices in firms and its effectiveness

BUL Practices Company	Work-related record keeping
A	■ ○
B	■ ●
C	■ ●
D	■ ●
E	■ ○
F	■ ○
G	■ ○

- Has the BUL practice ● BUL practice is embedded
- Do not have the BUL practice ○ BUL practice is absent or not embedded

4.2.4 Internal training

Training for employees for professional skills based on internal trainers is an important mechanism for formal knowledge sharing between experienced employees and others.

The criteria of embedded internal training are developed from the literature and summarised in Table 4-10

Table 4-10: Criteria for embedded and not embedded internal training

Embedded	Not embedded
Including all employees or including production workers	Limited to manager or senior engineers.
Has formal internal training development programmes	Does not have formal internal training development programmes
Frequently or regularly	Occasionally

4.2.4.1 Case A (Central SOE, Auto)

In Case A, the company does not provide employees with training apart from induction training for new recruits. Production workers are all recruited directly from technical schools so they are expected to have sufficient levels of skills and knowledge to carry out their jobs. Engineers are all university graduates holding relevant degrees.

Workers and engineers in Case A do not receive any training for their professional skills.

Only some engineers are occasionally allowed to attend industrial conferences.

Therefore, Case A does not have internal training programmes.

4.2.4.2 Case B (Local SOE, Auto)

In Case B, the company provides intensive internal training to all employees including managers. They have a training programme entitled Saturday Training Day, which provides training sessions to all employees according to their positions. Shop floor

workers and engineers are trained by experienced senior workers and engineers who have expertise in certain fields. Experienced workers and engineers can apply to become internal trainers after they have passed an internal trainer development programme. Managers are trained by senior level managers who have knowledge in management theories and rich, firm-specific knowledge.

In addition, this internal training programme is also integrated with an external training system. The company will provide external training to employees when managers believe the knowledge of the workforce needs updating.

To conclude, Case B has an embedded internal training system to improve the knowledge base of their workforce.

4.2.4.3 Case C (Local SOE, Auto)

In Case C, the company has a very unique, internal training system among all cases in this study, because they have an in-house college. This university was an in-house technical school providing workers only to Case C. However, after the school grew rapidly during the last decade, they upgraded it to a college and it became a professional training institution open to the general public.

Case C provides two types of internal training programmes. The first one is a compulsory course aiming to re-train workers who are not proficient in carrying out production routines. Employees who make mistakes at work are sent to the college for two weeks. They can graduate if they pass a test, which asks them to carry out their production routines ten times without making any kind of mistake, and within a limited time.

Second concerns selective courses available to all employees who want to upgrade their skill sets. Employees can select their own based on their working schedules. These

courses are generally free to employees. However, some advanced courses required employees to pay 30% towards the tuition fee and the company will absorb the remainder.

Most trainers in the college are internally developed. They encourage experienced employees to develop their own courses and teaching materials. The contents of each course and its teaching materials are reviewed by the Department of Employee Training. After the course has been approved, the teaching materials must be renewed every year based on reflections of trainees from the previous year.

To conclude, Case C has a unique, well-established and embedded internal training system based on an in-house college that is available to all employees.

4.2.4.4 Case D (Private, Auto)

In Case D, the company does not have any training programme for workers to develop their professional skills. However, the CEO states: “... *Occasionally we will organise in-house training to give our engineers lessons on certain topics. These lessons are all delivered by our Senior Engineers who often attend industrial meetings...* (D-CEO)”.

Therefore, Case D has some kind of internal training system on professional skills for engineers. However, because the training is only occasional and limited to its engineers, it is considered as not embedded.

4.2.4.5 Case E (Central SOE, Railway)

In Case E, the company does not have any form of training for employees apart from induction training to new recruits. Shop floor workers are recruited directly from technical schools. Therefore, they are expected to have a sufficient level of skill and knowledge to carry out their jobs. Engineers are all university graduates holding relevant degrees. Only occasionally can some engineers attend industrial conferences.

Therefore, Case E does not have any internal training programme.

4.2.4.6 Case F (Central SOE, Railway)

In Case F, the company does not have training for any of its employees including the managers. They overwhelmingly rely on suppliers to produce complex parts due to a lack of experienced workers in the production department. However, the company still does not have any form of training for workers to improve their production capability.

Therefore, Case F does not have any internal training programme in place.

4.2.4.7 Case G (Central SOE, Railway)

In Case G, they do not have any form of training for employees. They outsource all of their production tasks to their suppliers, so they do not need to train production workers. Although they have an assembly plant, assembly workers only received training from their foreign parent company at the very beginning when the assembly line was installed. Nor was any further, subsequent training provided by Case G to their assembly workers.

Therefore, Case G does not have any internal training programme in place.

4.2.4.8 Summary of Internal training for employees

From the analysis of internal training across these cases, only a few of them provide internal training to their employees to improve their professional skill sets. None of the central SOEs in either the auto or railway sectors have internal training systems. Conversely, all local SOEs have well designed and highly embedded internal training systems to improve skills within their respective workforce. In addition, the private firm (Case D, private, auto) provides some internal training to its managers. However, this system is only limited to managers so its workers do not receive any training to improve their skill sets.

Table 4-11 summarises the internal training programmes in all cases and is accompanied by typical quotes from interviewees.

Table 4-11: Summary of internal training practices in all cases and effective evaluation

Internal training		
Company	Practices	Quotes
A	None	<p>“... we only have before job training and maybe some training for management trainees.” (A-VP)</p> <p>“We do not have regular training at company level. We will send our engineers to industrial meetings organised by universities and research institutes.” (A-CE)</p>
B	Saturday Training for all employees is partially delivered by an internal trainer, and is partly delivered by an external trainer from professional bodies.	<p>“... our Saturday training day is our main training system including everyone in our company. We train our employees based on their needs in their daily work. Management personnel are taught by high-level managers who know management theories. Of course, we will have external trainers to tell us new theories ... Engineers are mainly taught by experienced senior engineers, who have been successful in many projects or won awards. Their trainers could also be professors from universities or research institutes. ... Workers are mainly taught by our own in-house trainers who normally have worked in our company for more than ten years. They will have rich experience in production and have won many awards in skill competitions at different levels.” (B-CE)</p>
C	<p>Regular training for workers and managers at the in-house university</p> <p>Experienced workers can become internal lecturers to teach specific topics based on their work experience</p>	<p>“ We have regular training for our skilled workers based on their speciality fields. All that training is delivered by our university. ... We also have management courses for managers. ... For engineers, we ask local universities to provide training courses for them. ... [Experienced workers could] become lecturers to teach courses in our university. They need to design their own teaching material and pass evaluation by our Employee Training Department” (C-VP)</p> <p>“...Our employees will regularly go back to our uni to have training...” (C-AM)</p> <p>“We have our training programme for experienced workers and engineers become</p>

		part time teachers in our university. So they will be able to teach others with their work experiences.” (C-DoT)
D	In-house training for engineers by senior engineers	<p>“ ... Occasionally we will organise in-house training to give our engineers lessons on certain topics. These lessons are all delivered by our Senior Engineers who often attend industrial meetings.” (D-CEO)</p> <p>“We do not have much training for workers. They have some meetings among them to share work experiences. ... Our R&D department will have training for engineers if our senior engineers have been to external conferences. They will bring back some new information in the market.” (D-VP)</p> <p>“We do not have training for our workers apart from giving them good masters at beginning.” (D-HoP)</p>
E	None	“Our company will send our engineers to have seminars in universities in our system. Mostly the Beijing Jiaotong University.” (E-CE)
F	None	“We occasionally will send our engineers to attend seminars at universities. ... every department in our company will have many meetings, like daily meetings, weekly meetings etc. All of these meetings can be used to share work experiences.” (F-CE))
G	None	“Apart from training provided by [parent company] on product assembly, we do not have any training for our workers.” (G-CEO)

Finally, an illustrative table is produced to display the empirical findings clearly (See **Error! Not a valid bookmark self-reference.**) showing which cases have adopted an internal training programme, and whether or not it is embedded.

Table 4-12: Summary of findings on Internal Training System practices in firms and its effectiveness

BUL Practices Company	Training system comprised of internal trainer(s)
A	□ ○
B	■ ●
C	■ ●
D	■ ○
E	□ ○
F	□ ○
G	□ ○

- Has BUL practice
- BUL practice is embedded
- Do not have BUL practice
- BUL practice is absent or not embedded

4.2.5 Job rotation of employees

Job rotation of employees aims to allow them to develop firm-specific knowledge through working in different areas.

Table 4-13: Criteria for embedded and not embedded job rotation programme

Embedded	Not embedded
Structured and planned	Unstructured and unplanned
Including junior employees	Only limited to managers

The level of embeddedness of a job rotation programme in all seven cases will be evaluated in the following sub-sections. The criteria of an embedded job rotation programme are developed from the literature and summarised in Table 4-7

4.2.5.1 Case A (Central SOE, Auto)

In Case A, the company does not have any form of job rotation programme for both employees and managers.

4.2.5.2 Case B (Local SOE, Auto)

In Case B, the company has a planned job rotation programme for its new recruits. Newly recruited administration staff are required to work in many different departments in the first two years to quickly develop firm-specific knowledge. Moreover, they need to work on the production shop floor for at least six months to understand how production workers operate. This helps the administration staff to easily communicate and interact with the production department in the future.

Therefore, Case B has an embedded job rotation programme in place to allow administration staff to quickly develop firm-specific knowledge.

4.2.5.3 Case C (Local SOE, Auto)

In Case C, their job rotation programme is about the same as that used in Case B. Management trainees in Case C are moved around the company in their first two years so the programme is planned. In addition, they need to work together with the production staff on a daily basis for six months during this two-year job rotation programme to understand how the factories operate. This programme helps new management trainees to quickly develop firm-specific knowledge. In addition, this programme allows them to learn practical production knowledge, which is not taught in universities.

Therefore, Case C has an embedded job rotation programme in place to allow administration staff to quickly develop firm-specific knowledge.

4.2.5.4 Case D (Private, Auto)

In Case D, the company does not have any form of job rotation programme for both employees and managers.

4.2.5.5 Case E, F and G (All of them are Central SOEs, Railway)

None of the three SOEs in the railway equipment sector have any form of job rotation for their employees and managers.

4.2.5.6 Summary of job rotation

From analysing the job rotation programmes used in these cases, only local SOEs have job rotation programmes. Moreover, they are all well planned and aimed at new recruits, so they are all embedded BUL practices.

Table 4-14 summarises the job rotation programmes in all cases and is accompanied by typical quotes from interviewees.

Table 4-14: Summary of job rotation programmes in all cases and effective evaluation

Job rotation of employee		
Company	Practices	Quotes
A	None	N/A
B	Job rotation for management trainees for two years Job rotation among some CNC workers	“... we have a job rotation scheme for new management recruits. They will work in different departments in the first two years... They will also need to work in ... production factories to learn how our company works.” (B-BM) “We sometimes have job rotation for part of the skilled workers who studied CNC techniques in school. This is because most of the technical schools will teach students with various CNC machineries. They normally will learn CNC lathe, CNC mill, CNC machining centre. So, we will move this kind of worker around our factories to check which kind of machinery they are most competent with.” (B-VP)
C	Job rotation for management trainees for two years	“We arrange our new management trainees to move around our company in their first two years after they join our company ... For workers, we do not have standardised job rotations.” (C-DoT)
D	None	N/A
E	None	N/A
F	None	N/A
G	None	N/A

Table 4-15: Summary of findings on Job Rotation practices in firms and its effectiveness

Company \ BUL Practices	Job rotation of employees
A	□○
B	■●
C	■●
D	□○
E	□○
F	□○
G	□○

■ Has BUL practice ● BUL practice is embedded
 □ Do not have BUL practice ○ BUL practice is absent or not embedded

Finally, an illustrative table is produced to display the empirical findings clearly (See Table) showing which cases have adopted job rotation programmes, and whether or not they are embedded.

4.3 Comparison of the Level of BUL Embeddedness

This section summarises the research findings in the previous sections. An illustrative table is produced to clearly show the findings (see Table 4-16). Moreover, cases are ranked, based on the number of their embedded BUL practices (see Table 4-17).

As discussed in Section 3.6.1.2, this research rates the level of BUL embeddedness of those cases studied. The level of BUL embeddedness is a relative measure of how many embedded BUL practices have been adopted by cases in comparison to others. Three levels of ratings are given to those cases studied: good BUL embeddedness, moderate BUL embeddedness, and poor BUL embeddedness. The rating of the level of BUL embeddedness of firms is presented in Table 4-17.

adopted some of BUL practices. Interestingly, amongst the four central SOEs studied, two of them have moderate BUL embeddedness as they have some embedded BUL practices; while the other two central SOEs have only poor BUL embeddedness as they only have one embedded BUL practice.

4.4 Chapter Conclusion

4.4.1 Addressing research question one

To address research question one - “*Do China’s firms have bottom-up learning (BUL) practices to develop their innovation capability, and how embedded are BUL practices?*” this chapter analysed seven cases in terms of what BUL practices the firms in the study had adopted, how BUL practices in each case operate, and how embedded these BUL practices are in each case.

Five types of BUL practice adopted by the seven cases have been analysed through cross case analysis. Moreover, the operational detail of BUL practices adopted in each case has been discussed to understand how their BUL practices operate. Finally, based on the operational detail of BUL practices, the embeddedness of all BUL practices in each case has been evaluated according to criteria developed from various literature (see Section 3.6.1.1).

This research found that Chinese firms have adopted BUL practices. However, empirical evidence shows that BUL practices adopted, by the cases in focus, vary in two dimensions. Firstly, *the type* of BUL practice adopted by each of the seven cases varies. Secondly, *the degree of embeddedness* of adopted BUL practices varies amongst cases. This is because some cases have the same type of BUL practice, like the Kaizen programme or suggestion scheme, but the operational detail of their practices differs. Differences in the operational

detail of BUL practices led to differences in the embeddedness of the same type of BUL practice across the cases.

Empirical findings concerning the characteristics of embedded BUL practices will be summarised in the following subsections and grouped according to the five types of BUL practices.

4.4.1.1 Proposal system

The four main characteristics of an embedded proposal system found in this study are:

Firstly, all embedded proposal systems are monitored by an office or a committee at company level, these are managed directly by senior level managers. Therefore, these senior managers have the authority to directly implement good suggestions. This kind of management structure shows the level of management support, given to the proposal systems, is high.

Secondly, all embedded proposal systems used by these cases have frequent suggestion collecting programmes running at least twice a year. Moreover, all embedded proposal systems have a formal and structured evaluation system led by a company level office, or committee, to select good quality suggestions.

Thirdly, all embedded proposal systems feature a high involvement of shop floor workers instead of only including experienced engineers or managers. This shows that the level of employee involvement in those proposal systems is high.

Fourthly, all embedded proposal systems generously reward good quality suggestions with financial rewards. This reflects that the level of organisational encouragement is high.

Moreover, evidence from some of the companies studied shows that employees have concerns about being penalised if they propose suggestions to company level suggestion schemes when directly bypassing their mid and line managers. For example, employees in Case A (Central SOE, Auto) expressed their concerns about being seen as challenging the authority of their supervisors if they submit suggestions directly to the company's suggestion scheme. This suggests that an effective proposal system requires a company culture where mid and low-level managers are actively open to suggestions and criticism from their subordinates, and do not feel offended if high level managers collect information directly from shop floor workers. Otherwise, they could potentially represent a hindrance to the effectiveness of the proposal systems. This issue of employees reporting to their seniors whilst bypassing mid-level managers has been briefly discussed by Child (1974) who suggests that mid-level managers consider being bypassed as undermining their management authority. Therefore, it is a conflict between different levels of managers that has to be resolved before having an effective proposal system.

Case B (Local SOE, Auto) effectively resolved the conflict between different levels of managers by making their proposal systems compulsory, which requires everyone to propose some suggestions every year. Because all employees, including managers, have to propose suggestions, mid and low-level managers would no longer feel challenged by their subordinates, or feel their authority was being undermined.

4.4.1.2 Problem-solving mechanisms

All cases have defined problem-solving mechanisms based on multi-disciplinary problem-solving teams. This result could be partly explained by strict requirements of the quality control process. All seven cases are governed by industrial standards, all of which specifically require firms to have structured problem-solving mechanisms to solve

technological problems. Therefore, the problem-solving mechanisms in all cases are considered as embedded.

However, some cases adopted more advanced problem-solving methods while other firms use more simplistic methods. Two local SOEs and the one private firm have implemented well known structured problem-solving tools, namely 8D and PDCA.

Others have not used well known, structured problem-solving approaches even though they also rely on a multi-disciplinary problem-solving team.

4.4.1.3 Work-related record keeping

All seven cases have adopted formal record keeping systems to collect and manage their work-related records. However, only three of them have embedded record keeping systems. They are two local SOEs (Cases B and C, Auto) and one private firm (Case D, Auto).

Empirical evidence shows that an embedded work-related, record keeping system shows two main characteristics. Firstly, embedded record keeping systems are highly integrated within the company's OA system based on ICT technology. Their systems allow employees to record problems encountered during daily production processes in multiple formats including text, pictures and videos. Secondly, embedded record keeping systems do not only collect information from employees at work, but also invest effort to review the records regularly to identify production problems and good practice. Because these records are kept online within their OA system, managers at different levels can easily review those records.

4.4.1.4 Internal training

Based on empirical findings in this research, only three out of the seven cases have adopted internal training practices. Moreover, only two of them have highly embedded internal training practices, which are the two local SOEs.

Empirical evidence shows that embedded internal training practices have three characteristics. Firstly, internal training programmes are open to all employees. Secondly, embedded internal training practices are underpinned by well-structured internal trainer development programmes. Anyone could apply to become an internal trainer if they have expertise in a certain area. They will be provided with complete training on how to organise workshops and to give lectures. Thirdly, the frequency of internal training is very high in those two firms. For example, Case B (Local SOE, Auto) provides internal training workshops every Saturday.

4.4.1.5 Job rotation of employees

It has been found in this research that only two of the local SOEs have adopted job rotation programmes and these practices are embedded.

Empirical evidence shows that embedded job rotation programmes have two characteristics. Firstly, they have well planned rotation routes for employees to develop knowledge in multiple fields. Secondly, job rotation programmes are targeted to new recruits aiming to develop their firm-specific knowledge quickly across all functions.

4.4.2 Addressing research question two

To address research question two – *“How the level of firms’ BUL embeddedness varies amongst firms with different ownership?”* “this chapter analysed the relationship between the types of firms’ ownership and the level of embeddedness of BUL practices as a whole.

Seven cases have been grouped into three groups based on the number of embedded BUL practices adopted by each case.

In the following subsections, findings regarding the relationship between types of firm ownership and levels of embeddedness of BUL practices will be summarised.

4.4.2.1 Good BUL embeddedness

Empirical evidence shows that local SOEs have the highest number of embedded BUL practices. This group include Cases B and C who are market leaders in China's commercial vehicle industry. These two SOEs are owned by the local government in different regions in China. This empirical result suggests that when SOEs are owned by the local government, they are more likely to have highly embedded BUL.

4.4.2.2 Moderate BUL embeddedness

Empirical evidence shows that private firms and some central SOEs have adopted a moderate number of embedded BUL practices. This group includes Case D (Private, Auto), and Cases F and G (Central SOEs, Railway). This empirical finding reflects that the combination of institutional factors faced by private firms and some central SOEs have some influence on their incentive or capability to adopt embedded BUL practices.

4.4.2.3 Poor BUL embeddedness

Empirical evidence shows that two central SOEs, Case A (Auto) and Case E (Railway) have only adopted one embedded BUL practice. This finding reflects that some central SOEs face a certain combination of institutional factors that significantly influence their incentive, or capability, to adopt embedded BUL practices.

Chapter 5: GROUP-CASE ANALYSIS: Investigation on the Impact of China's NSI on the Level of BUL Embeddedness of Firms

5.1 Introduction

This chapter aims to investigate the level of BUL embeddedness variations amongst the seven cases studied in this research, and how the differences are explained by the impact of China's NSI. The seven cases will be analysed through group-case analysis, based on three case groups, based on the levels of BUL embeddedness as developed in Chapter 5.

This chapter provides empirical evidence to address research question three: *“How does China's corporate governance system and firms' access to capital influence the adoption of embedded BUL practices in firms?”*

As already discussed in the literature review chapter Section 2.5.3, three assumptions are made in this thesis based on extensive literature. The three assumptions justify why firms should adopt BUL to develop innovation, why BUL requires long-term planning by top managers, and why BUL requires top managers to have firm-specific knowledge. The three assumptions have been developed from the literature making them theoretically justified.

- a) **BUL leads to improved innovation capability and better innovation performance, which consequently leads to improved economic performance.**
--- Thus, top managers of firms will adopt BUL practices if they want to have good innovation along with improved economic performance.

- b) **BUL practices require long term investment before their benefits can be perceived in terms of better innovation capability or performance.** --- Thus, top managers who will only remain in their position for 4-5 years are less likely to adopt embedded BUL practices, as they are unable to anticipate the benefit of those practices within their period of employment.
- c) **BUL is more difficult as it is less visible to top managers who do not have firm-specific knowledge. It is because BUL tends to occur amongst employees on a daily basis.** --- Thus, outsiders who do not have sufficient firm-specific knowledge are less likely to have an awareness of the BUL activities taking place on the shop floor. Even if they noticed such learning activities, they would not adopt BUL practices or facilitate them as they are unaware of the benefits of such learning effects.

Synthesised from the existing literature, three institutional factors have been identified to study and explain how China's corporate governance system, and firms' access to capital, influences the level of BUL embeddedness in firms, namely: 1) whether the top manager is an insider or an outsider (Cai and Tylecote, 2005; Liu and Tylecote, 2009), 2) whether the length of employment of the top manager is short-term or long-term (Cai and Tylecote, 2005; Tylecote, Cai and Liu, 2010), and 3) the level of a firm's access to capital (Peng *et al.*, 2005; Yiu and Lau *et al.*, 2005).

Whilst performing the data analysis, it was noted that the three institutional factors could not sufficiently explain the findings from the research. Empirical evidence shows that the level of market competition that a firm faces has a crucial impact on its level of BUL embeddedness. Empirical evidence in this research shows that competition increases the top managers' incentive to adopt embedded BUL practice, thus to improve the firm's

economic performance and maintaining its market share. Therefore, the fourth institutional factor, namely the market competition factor, is added to the original framework developed from previous literature, to fully explain the research findings.

This chapter is organised as follows. Section 5.2 analyses the impact of government appointment of top managers for SOEs on the level of embeddedness of BUL practices. This section will investigate the background of top managers in the seven cases studied to explore whether their top managers are insiders or outsiders. Section 5.3 investigates the impact of the length of employment of a top manager on the level of BUL embeddedness of firms. This factor explains the level of top managers' incentives to adopt embedded BUL practice. Section 5.4 studies the impact of the level of firm's access to capital on the level of BUL embeddedness of firms. Each case will be studied to establish how many forms of capital they have received from the government. This factor explains whether the level of firms' access to capital influences top managers' capabilities to engage with innovation. Section 5.5 investigates the impact of market competition on the level of BUL embeddedness of firms. This factor is added during data analysis to fully explain the research findings. Market competition influences the incentive of a top manager to adopt embedded BUL practices to address threats from rivals and to defend their market share. Section 5.6 concludes this chapter by discussing research findings and developing insights for the discussion chapter.

In the analysis that follows, the names of cases are replaced by case codes for confidentiality purposes. A full list of case codes and their details can be found in Appendix C.

To allow readers to navigate easily, a note of case ownership and sector will be included in brackets after the case code. For example, Case A is a local SOE in the automobile sector. It will be presented as “Case A (Local SOE, Auto)” to remind readers. Similarly, the word “Railway” is used to show that the cases are in the railway equipment sector.

The informants’ names are hidden by using codes based on their position. For example, the Vice President in Case A is abbreviated as “A-VP”. This coding system will be used at the end of direct quotes of interviewees provided in the following analysis. A full list of codes for the interviewees can be found in Appendix C.

5.2 An Insider or an Outsider as the Top Manager

To study how management appointment of SASAC (government) influences adoption and embeddedness of BUL practices, three case groups (good, moderate and poor embeddedness) will be compared in terms of whether the top manager is an insider or an outsider. Based on work performed by Tylecote and his colleagues (Tylecote and Conesa, 1999; Tylecote and Ramirez, 2006; Tylecote and Visintin, 2008; Liu and Tylecote, 2016), two attributes determine whether managers are insiders or outsiders.

- a) Whether the top manager of a firm is an insider or outsider. This indicates the level of the top manager’s firm-specific knowledge which determines the top manager’s capability to observe less visible innovation activities like technical problem solving at shop floor level.
- b) Length of employment of the top manager. This determines whether he/she has had the opportunity to develop firm-specific knowledge on the job. If an outsider has been appointed but could remain as the top manager for more than 10 years,

he/she is considered as an insider as he/she has had sufficient time to develop firm-specific knowledge at work.

The background of the top managers of the cases studied will be analysed to identify whether they are insiders or outsiders. Two criteria have been used to distinguish between insiders and outsiders, namely: 1) whether the top manager has worked at the company before he/she was appointed to the top manager role; and 2) if the current top manager was appointed from outside of the firm, how long had he/she remained at this position. Ten years' experience is used as a boundary to distinguish whether top managers could develop in-depth firm-specific knowledge. Thus, in a case where a top manager was an outsider at the time he/she was appointed, he/she is considered as an insider if he/she has stayed in this position for more than ten years.

An insider top manager would have high-level firm-specific knowledge that has developed over the years of working in their company so they have an in-depth understanding about how the company and shop floor operates on a daily basis. So that they could observe less visible innovation efforts like problem solving at shop floor level.

An outsider top manager would have little or no firm-specific knowledge as they have never worked in the company or even in any relevant industry. Thus, they have no knowledge of how the company and shop floor operates. Consequently, they are incapable of observing less visible innovation efforts like problem solving at shop floor level.

Since top managers of SOEs in China are directly appointed by central or local government, whether an insider or an outsider is to be appointed as a top manager of any SOEs is not a decision that SOEs can make. Based on previous literature, this is firmly

the decision of central or local government to appoint either an insider or outsider to the role of top manager of a SOE.

Therefore, government policies and decisions regarding local and central SOEs have a great deal of impact on whether top managers of SOEs have sufficient firm-specific knowledge to observe less visible learning and innovation efforts like BUL. Consequently, the embeddedness of BUL practices is likely to be weak if an outsider has been appointed. This is because outsider top managers lack the capability to observe less visible learning and innovation efforts like BUL, therefore, such expensive and time-consuming BUL practices are unlikely be appreciated.

5.2.1 Good BUL Embeddedness Group

The analysis given in Chapter 5 demonstrates that Case B (Local SOE, Auto) and Case C (Local SOE, Auto) have the highest number of embedded BUL practice.

Because both cases are local SOEs owned by different local governments, their top managers are directly appointed by their local SASAC on behalf of the local government. In the case of Chinese SOEs, the Chairman of the Board of Shareholders (Chairman) is the official representative of SASAC. Therefore, the Chairman of SOEs has the most authority in decision making, higher than the general manager (or CEO). When changes need to be made in the management structure of SOEs, especially when such change is based on instructions issued by SASAC, the Chairman would be the person to make the final decision and to answer directly to the local government. Thus, the Chairman is the core decision maker in Chinese SOEs, and thus has the greatest impact on embeddedness of BUL practices in SOEs.

5.2.1.1 Case B (Local SOE, Auto)

The current Chairman of Case B has been in this position since 2002 and was appointed directly by the local SASAC. So, he has worked in the same company and same position for nearly 15 years. This is a considerably long term of service for a top manager in China's SOEs in comparison to the traditional term of office of 4-5 years noted in other research (Liu and Tylecote, 2009).

The current Chairman of Case B was appointed when the previous Chairman reached retirement age. At the time he was appointed, he did not have any formal education within the automobile industry. However, before the current Chairman was appointed, he had worked very closely with Case B during his previous job as a government official who was responsible for developing industrial policies for the local automobile industry. It has been noted by VP that “... *His job was a government official in our local government who was responsible for developing local industrial policies. ... He worked intensively with our company to develop competitiveness of the local automobile industry... planned strategically by local government. ... Since our parent company is the only SOE [large corporate group] in the local automobile sector, he worked closely with our company to work out ways to improve production capability and product quality [of commercial vehicles]. ... He was acting as a bridge connecting our company with the local government to apply for necessary capital...(B-VP)*”.

Therefore, the Chairman of Case B is considered as having in-depth, firm-specific knowledge. This was because the current Chairman of Case B had had opportunities to develop some firm-specific knowledge before being appointed. Furthermore, the current Chairman had had nearly 15 years of work experience in Case B.

5.2.1.2 Case C (Local SOE, Auto)

The current Chairman of Case C has been appointed by a local SASAC in 2015. Although the Chairman has only been in this position for couple of years at the time of this research, the Chairman has spent his entire career in Case C, taking up his employment immediately after graduating from Tsinghua University in 1987. He started as a technologist in the R&D department in Case C and was gradually promoted over the years until being appointed as Chairman. Therefore, he has a high level of firm-specific knowledge after nearly 30 years of working in Case C.

5.2.1.3 Good BUL embeddedness case group summary

To sum up, the top managers in those SOEs with embedded BUL practices are all insiders so they have high levels of firm-specific knowledge making them capable of observing less visible innovation efforts like problem solving activities at shop floor level.

From previous analysis, some findings could be demonstrated in relation to whether an insider or an outsider had been appointed as a top manager for any SOEs. Firstly, empirical evidence in this research shows that the local government likes to appoint insiders as top managers of local SOEs, those who have firm-specific knowledge to be able to observe less visible learning efforts. This is different from what was once revealed in previous literature, where SOEs would only have outsiders as top managers. Both Case B and Case C are local SOEs in the automobile industry, thus, at least local SOEs have insiders as top managers. Secondly, those insiders tend to stay as top managers of local SOEs for long periods of time, which is different from the normal 4-5 years term of top managers that is suggested in the literature. The long-term employment of top managers allows them to develop in-depth, firm-specific knowledge so that they understand how the firm operates and they are able to observe less visible BUL activities on the shop floor.

5.2.2 Moderate BUL embeddedness group

From the analysis outlined in Chapter 5, the findings show that Case D (Private, Auto), Case F (Central SOE, Railway) and Case G (Central SOE, Railway) have a moderate number of embedded BUL practices.

Case D is a private limited company where shares are jointly owned by all of the managers and employees. Therefore, their top manager is the CEO elected by their managers and employees who are all shareholders.

Cases F and G are second tier³ subsidiaries who do not have a board of shareholders, thus they do not have a Chairman as their top manager as in Cases B and C. Therefore, the top managers of these two firms are the CEOs.

5.2.2.1 Case D (Private, Auto)

Case D was a local SOE, however, it was privatised by the local government in 2006 following a management buyout. Managers and employees bought all the shares of Case D, and the current CEO owns the highest percentage of shares. Before 2006, the current CEO had already been the General Manager of the firm for almost 10 years. The CEO of Case D states that “... *I was appointed as the general manager in 1996. ... I started as an engineer in the R&D department in 1988. ... From 2005, our local government decided to sell some underperforming SOEs cheaply to private investors. We are one of those underperforming SOEs to be sold. I organised our managers and employees to buy out all of our shares so that we become working for ourselves and enjoy every cent we made...Because I invested a large amount of money when buying shares, I got the highest*

³ Second tier subsidiary of the SOE means that the case in question is a subsidiary of the parent company. The parent company is a larger subsidiary of a giant SOE (corporate group) owned directly by SASAC at different levels.

percentage of shares of our company... (D-CEO)". After Case D was privatised, the managers and employees asked the CEO to remain in post in the new private, limited company.

Therefore, the current CEO is viewed wholly as an insider, having a great level of firm-specific knowledge. Despite the CEO's 21 years of experience working as the top manager since 1996, the current CEO also worked as an engineer and at various managerial levels since 1988.

5.2.2.2 Case F (Central SOE, Railway)

Case F is a central SOE founded in 2003. The current CEO was appointed by the parent company on behalf of the central SASAC in 2013, however, he is due to retire⁴ in 2017. Therefore, at the time the current CEO was interviewed, the CEO stated that: "*... our parent company will appoint a mid-level manager in our parent company to take my position after I retire. The mid-level manager is going to retire in 5-6 years so the parent company wants him to be promoted to become a CEO in a subsidiary company before his retirement ... (F-CEO)*".

Because of the short time the current CEO will stay in Case F firm, he will be considered as an outsider who does not have a good level of firm-specific knowledge.

5.2.2.3 Case G (Central SOE, Railway)

Case G is a 50:50 JV between a central SOE and a foreign company. However, the foreign parent company does not involve itself in the management of Case G, they merely provide

⁴ The official retirement age of employees in SOEs is 60 for men and 50 for women. However, if approved by the parent company and SASAC, senior level managers could extend this limit to 65 for men and 55 for women.

licences for their technology. Therefore, the top manager of Case G will be appointed by the parent company (the central SOE) on behalf of the central SASAC.

The current CEO of Case G was appointed in 2012 by the parent company on behalf of the central SASAC. He was appointed because the parent company considered sending him to manage a subsidiary as an opportunity to develop his resume. The CEO of Case G advises that: “... *before I was appointed as CEO to our company, I was a Deputy Head of R&D department in our parent company... the Chairman in our parent company wanted to promote me to senior level manager but there was no vacant position until few years later. ... So, I have been sent to this subsidiary (Case G) as CEO which is about equivalent to the VP level in our parent company. ... Our Chairman considers this as an opportunity for me to develop my CV so that I can easily be recalled back to the parent company in the future as a senior level manager in a few years. ... (G-CEO)*”.

Therefore, due to the short term that the current CEO would work at Case G, he is considered as an outsider who would not have sufficient firm-specific knowledge.

5.2.2.4 Moderate BUL embeddedness in the case group summary

To conclude, within the case group with moderate embeddedness of BUL practices, Case D, a private company, has an insider top manager who worked as a CEO for nearly 21 years. Conversely, both central SOEs, Case F and Case G (Railway), have outsiders as top managers who will only work as a CEO for a short term, that being around 5 years.

Interestingly, in Case F (Central SOE, Railway), the current top manager was appointed when, in approximately 5 years, he would reach the compulsory retirement age. Moreover, the top manager who would be his replacement would also be retiring in 5-6 years. Therefore, both the current and subsequent top manager of Case F will only stay for one

term of office, which is traditionally around 4-5 years. On reaching the retirement age of 65, by law, they will have to leave the companies.

Another central SOE (Case G, Railway), has an outsider as its top manager, but in this company, for different reasons to those already mooted. The parent company considers sending mid-level manager to subsidiaries as a means to improve their management skills. After 5-6 years they would be recalled to the parent company and be promoted to senior level management positions.

Therefore, the top managers of two central SOEs in this group were all outsiders when they were appointed. They were all appointed by the parent company when they were mid-level managers in their respective parent companies. These top managers would only work for another 5 years before they must leave. This means top managers in central SOEs in this particular group, do not initially have firm-specific knowledge, and they do not have sufficient time within the firm to develop such knowledge, due to the short time left before their retirement. This could be one of main reasons why they do not have good BUL embeddedness.

5.2.3 Poor BUL embeddedness group

From the analysis given in Chapter 5, Case A (Central SOE, Auto) and Case E (Central SOE, Railway) have the least number of embedded BUL practices amongst all the cases studied in this thesis. These two companies are all large first tier subsidiaries⁵ fully owned by giant central SOEs (a corporate group directly owned by central SASAC), and the top

⁵ First tier subsidiary of the SOE means that the firm studied is a large size subsidiary owned by a giant SOE (corporate group) owned directly by SASAC at a different level.

managers in Cases A and E are directly appointed by the parent company on behalf of the central SASAC.

In Cases B and C, the Chairman of the Board of Shareholder is the key decision maker. Therefore, the background of the chairmen in Cases A and E will be discussed in the following paragraphs to establish whether they had firm-specific knowledge when they were appointed.

5.2.3.1 Case A (Central SOE, Auto)

Case A is at the transformational stage between its old and new Chairmen at the time of interview in early 2016. The new Chairman was appointed directly by SASAC from outside so he has not worked in Case A or the parent company before. The VP of Case A stated that: “... *our new Chairman was a secretary of the governor of a province. He has not worked in this (automobile) sector before. ...he is a total layman (person not knowing the technology) selected by our parent company or even by central SASAC directly from outside of our system (central SOEs in automobile sector) ... (A-VP)*”. Therefore, because the new Chairman has neither firm-specific nor industry-specific knowledge, is considered as a complete outsider who is unable to observe less visible innovative efforts.

5.2.3.2 Case E (Central SOE, Railway)

The CEO and Chairman of Case E is the same person who was appointed in 2011. Before he was appointed as CEO and Chairman of Case E, he was the Chairman of other subsidiaries owned by CRRC. At the time of interview, the CEO/Chairman had worked in Case E for nearly 6 years. It is not yet known whether he will be transferred to other SOEs in the future. However, the unofficial expectation amongst employees and

managers is that he will be allowed to remain in position for another 3-4 years until his retirement.

Therefore, the CEO/Chairman of Case E is still considered an outsider due to the short time he has worked in the company. However, if allowed to remain in his position for another 3-4 years, he could become an insider having, by that point, developed firm-specific knowledge.

5.2.3.3 Poor BUL embeddedness case group summary

To conclude, empirical evidence in this research shows that the central government favours appointing outsiders as top managers for central SOEs. In addition, those outsiders will only enjoy short term employment as a top manager for approximately 5 years. Therefore, they do not have firm-specific knowledge when they are appointed to the role of top manager, and do not have the opportunity to develop firm-specific knowledge due to the short term they would remain in the firms. Consequently, those outsiders are unlikely to adopt highly embedded BUL practices because they are unable to observe them and would not appreciate any BUL efforts made as these are less visible to outsiders.

5.2.4 Summary of findings from the analysis of management

appointments

From the analysis of management appointments of insiders or outsiders as top managers of SOEs, the findings are revealed and summarised in Table 5-1.

Firstly, empirical evidence in this research reveals that the local government (local SASAC) prefers to appoint insiders who have firm-specific knowledge as top managers of local SOEs. Moreover, the insiders are appointed for a long term so they have

opportunities to develop in-depth, firm-specific knowledge. In Cases B and C (Auto) as local SOEs, they have both appointed insiders as top managers. In addition, top managers of those two local SOEs have all worked for at least 15 years in the role of top manager. Therefore, top managers in those two local SOEs have the knowledge and capability to observe and appreciate BUL efforts that are less visible to outsiders.

Table 5-1: Summary of findings on management appointments of top managers by governments

Case	Case group	Ownership and sector	Total years worked in the current company (including time before being appointed as top manager)	Insider or outsider as top manager
B	Good	Local, Auto	15	Insider
C	Good	Local, Auto	30	Insider
D	Moderate	Private, Auto	29	Insider
F	Moderate	Central, Railway	5	Outsider
G	Moderate	Central, Railway	6	Outsider
A	Poor	Central, Auto	0	Outsider
E	Poor	Central, Railway	6	Outsider

Rows in grey could not be explained by the findings in this section - thus requires further analysis.

Secondly, empirical evidence in this research shows that the central government (central SASAC) likes to appoint outsiders who do not have firm-specific knowledge as top managers of central SOEs. Moreover, the outsiders are appointed for only a short term of around 4-5 years so that they do not have the opportunity to develop more in-depth, firm-specific knowledge. Case A (Auto), Case E, Case F and Case G (Railway), as central SOEs, have all appointed outsiders as top managers in a parachute manner. Moreover, top managers of those central SOEs only stay for around 5 years, and then they will leave the firms. Thus, due to their short-term employment in the role of top manager, they do not have the opportunity to develop in-depth, firm-specific knowledge. Therefore, top managers in those four central SOEs do not have the knowledge and capabilities to observe and appreciate BUL efforts that are less visible to outsiders.

Thirdly, empirical evidence in this research shows that by having as insider as the top manager of the firm is no guarantee to lead to higher levels of embeddedness of BUL practices. Case D (Auto), as a private limited company, has an insider as a top manager for nearly 21 years. Nevertheless, the number of embedded BUL practices is only at a moderate level amongst all cases studied. This phenomenon may not be explained by whether an insider or an outsider was appointed, or selected, as top manager of the company. Thus, this finding suggests that by only having insiders as a top manager is not wholly sufficient for firms to have highly embedded BUL practices. Therefore, this requires more analysis in the following sections to offer an explanation.

Fourthly, empirical evidence in this research shows having an outsider as a top manager does not necessarily mean that the firm does not have embedded BUL practices. Case F and Case G (Railway) are central SOEs who have outsiders as top managers but they have an average number of embedded BUL practices in place in all cases. However, their moderate levels of embedded BUL practices could not be explained by having an outsider as the top manager in Case F and Case G (Central SOE, Railway). Thus, this phenomenon requires further analysis in the following section to establish other contributory factors.

5.3 Length of Employment of Top Managers

As suggested in other literature, top managers in Chinese SOEs tend to only serve a short period of time that is around 4-5 years. After that they will leave their SOEs. Due to the fact they will only manage the company for a short period of time, they have a tendency to only plan for short term profit, for instance, relying heavily on importing ready-made technological packages to boost production capability in the short term, whilst ignoring the internal development of long term learning and problem-solving capabilities (Liu and Tylecote, 2009, Tylecote *et al.*, 2010). In a scenario of long term employment of a top

manager, that is for more than 10 years, he would have to plan for the long-time performance of the company because his career, including any personal gain, is tied into the performance of the company. Because one assumption drawn from literature is that BUL leads to improved innovation capability, better innovation performance and increased economic performance, meaning top managers with long term employment would be more highly motivated towards the benefits of adopting embedded BUL practices in the long term. Therefore, long term employment of top managers increases the incentive to adopt long term management practices, like BUL practices, to improve internal learning and problem-solving capabilities.

Thus, the group-case analysis investigated the relationship between the length of employment of top managers in the seven cases studied, to better understand the levels of top managers' incentives to adopt embedded BUL practices with a view to improving the long-term innovation capability of firms.

5.3.1 The good embeddedness BUL group

5.3.1.1 Case B (Local SOEs, Auto)

As already discussed in Section 5.2.1.1, the top manager of Case B has been in his position for nearly 15 years at the point this study was prepared. Therefore, it is reasonable to conclude that the top manager of Case B has a high-level of incentive to adopt BUL practices because his personal gain is closely linked with the long-term prospects of the firm.

To conclude, because the top managers of Case B have long term employment, the level of the incentive to adapt embedded BUL practices to develop innovation capability is high.

5.3.1.2 Case C (Local SOEs, Auto)

As discussed in Section 5.2.1.2, the top manager of Case C has worked in this firm for nearly 30 years. However, he has only recently, 2 years ago, been appointed as Chairman. Thus, it is difficult to predict his length of tenure in this position.

However, it was found that the last top manager of Case C had been in the position from 1990 to 2015, which is for 25 years. He has a total of 46 years of working experience in Case C from 1969 to his retirement in 2015. Therefore, it is reasonable to assume that the local government prefers to appoint insiders as top managers in Case C, and the length of such an appointment is likely to be long term.

Thus, the incentive of the current top manager in Case C to adapt embedded BUL practices is high because his career prospects and personal gain are closely tied to the long-term prospects of the firm.

5.3.1.3 Good BUL embeddedness case group summary

Empirical evidence in this research shows that top managers in local SOEs are appointed by the government for long term employment. Therefore, their personal gains are closely linked with the long-term prospects of the firms in which they are employed. This makes them willing to plan for long term development of the firm's innovation capability through adopting embedded BUL practices.

Thus, although BUL practices require a long period of time before producing observable benefits, those top managers of local SOEs are willing to adopt them to develop the firm's innovation capability in the long run.

5.3.2 Moderate embeddedness BUL group

5.3.2.1 Case D (Private, Auto)

As discussed in Section 5.2.2.1, the top manager of Case D has been in his position for nearly 21 years. Because Case D is a private company, their top manager is not appointed by the government. Instead, the top manager is elected by their shareholders, these consist of all employees and managers of the company. Because the current top manager also owns the highest percentage of shares, his personal gain is closely linked with the long-term prospects of the firm.

Thus, because the top manager has enjoyed a long-term employment in his position, and his personal gain is closely linked with the long-term prospects of the company, the level of his incentive to adopt embedded BUL practice is high in order to improve the firm's innovation capability.

5.3.2.2 Case F (Central SOE, Railway)

As discussed in Section 5.2.2.2, the top manager of Case F was appointed for only 5 years. Moreover, he is due to retire in 2017. Thus, he could only work in this firm for 5 years. What is more, according to the CEO of Case F, the one who will take over his position after he retires will also retire in 5-6 years. This means the length of employment of the subsequent top manager of Case F will still be very short. With such a short period of administration, the current and subsequent top managers are unlikely to adopt BUL practices due to the long time needed for those practices to produce any benefits. In addition, because both the current and subsequent top managers were, and will be, appointed when they only have approximately 5 years left before reaching compulsory retirement age, their personal gains are not linked with the long-term development of the

firms. Consequently, their incentive to adopt embedded BUL practices to improve innovation capability is likely to be low.

5.3.2.3 Case G (Central SOE, Railway)

As discussed in Section 5.2.2.3, the top manager has been in his position for 6 years. It is unknown how long he might remain in this position because the length of tenure will be at the discretion of the parent company and central SASAC. According to the CEO of Case G, he expects to be transferred back to the parent company as a VP shortly. Because the previous CEO has only worked for this firm for 5 years, the length of employment of the current CEO is likely to be short and will end soon. Therefore, the personal gain of the current top manager is not closely linked with the long-term development of Case G due to the short term of his employment. Consequently, the level of his incentive to adopt embedded BUL practices is low.

5.3.2.4 Moderate BUL embeddedness case group summary

The previous analysis of Case D (Private, Auto), Case F and Case G (Central SOEs, Railway), shows that private firms offer long term employment to their top managers. However, top managers in two central SOEs have all been appointed short-term. Therefore, the level of the top manager's incentive to adopt BUL practice is high in private firms but low in central SOEs.

5.3.3 Poor embeddedness BUL group

5.3.3.1 Case A (Central SOE, Auto)

As discussed in Section 5.2.3.1, the current top manager of Case A has just been appointed by the parent company on behalf of the central SASAC in early 2016. Thus, he has only worked in Case A for one year. It is unclear whether he would stay long term or not as it

is solely up to the plans of the central SASAC. However, based on the experience from their last top manager, who has only worked for 5 years, the length of employment of the new top manager is unlikely to be long. Being such a short time that the top manager would remain with the firm, which is around 5 years, their personal gain is not linked with the long-term development of the firm. Therefore, the level of incentive of the top manager in Case A to adopt embedded BUL practice is low because the top manager would only stay for around 5 years.

5.3.3.2 Case E (Central SOE, Railway)

As discussed in Section 5.2.3.2, the top manager of Case E has worked in the firm for 6 years. There is no guarantee how much longer he would stay in this position. However, because he is going to retire in 3-4 years, the expectation within the workforce is to have him remain in position until retirement. Therefore, the expected time he will work as a top manager in Case E could reach 9 – 10 years in total.

Nonetheless, the length of employment of the top manager in Case E is still considered as short because firstly, the 9-10 years expectation is based solely on the expectations of the workforce, it remains the decision of the parent company and central SASAC. At this stage, no official or creditable information is available from the parent company and central SASAC regarding this issue. Secondly, 9-10 years as a top manager only barely meets the definition of long term employment in this thesis, which is at least 10 years. Thus, the length of employment of the top manager in Case E is still considered as short term in this thesis, due to the limited information available at this stage. Given this, the level of incentive of the top manager to adopt embedded BUL practices to develop innovation capability is low.

5.3.3.3 Poor BUL embeddedness case group summary

Empirical evidence in this research demonstrates that the level of incentive of top managers in central SOEs is low, this finding is based on the fact that top managers in both Case A (Central SOE, Auto) and Case E (Central SOEs, Railway) were only appointed in the short term.

5.3.4 Summary of findings on the length of employment of top managers

From the analysis based on the length of employment of top managers in each of the seven cases studied, the findings are developed and summarised in Table 5-2.

First, empirical evidence in this research shows that top managers in local SOEs (Cases B and C, Local SOEs, Auto) and in the private firm (Case D, Private, Auto) have high levels of incentive to adopt BUL practice. This is due to the top manager being appointed or elected for a longer term of at least 15 years (in Case B, local SOE, Auto).

Table 5-2: Summary of findings based on the length of employment of top managers

Case	Case group	Ownership and sector	Insider/outsider as top manager	Long/short term employment of top manager	Note number
B	Good	Local, Auto	Insider	Long term	
C	Good	Local, Auto	Insider	Long term	1
D	Moderate	Private, Auto	Insider	Long term	
F	Moderate	Central, Railway	Outsider	Short term	
G	Moderate	Central, Railway	Outsider	Short term	
A	Poor	Central, Auto	Outsider	Short term	2
E	Poor	Central, Railway	Outsider	Short term	3

Row in grey could not be explained by findings in this section – thus requires further analysis.

Notes:

1. The penultimate top manager worked for more than 15 years, so the current top manager is likely to be in position for a long time.
2. The current top manager will retire in 3-4 years, thus the general expectation amongst employees is that the CRRC will allow him to work until retirement. The unofficial anticipated time in post is 9-10 years. This is not official.
3. The current top manager is newly appointed by the parent company on behalf of the central SASAC. It is unclear how long he will remain. However, based on case of the previous top manager, it is likely to be only 4-5 years.

Second, empirical evidence in this research shows that top managers in central SOEs have less incentive to adopt BUL practices in general compared to local SOEs and private firms. This is due to their short-term employment in the firms. When employed as a top manager for a period of approximately 5 years, they do not plan for long term development of the firm's innovation capability.

Third, empirical evidence in this research shows that amongst central SOEs, top managers of two firms (Cases F and G, Central SOEs, Railway) have some incentive to adopt BUL practices because they face a degree of competition from the domestic market. Threats from rivals force them to have some BUL practice in place to develop some innovation capability to avoid being replaced by the parent company CRRC. However, because the other two central SOEs (Case A, Central SOE, Auto; and Case E, Central SOE, Railway) have little or no competition in their fields, the top manager's incentive to adopt BUL practices is low.

Fourthly, the moderate level of embeddedness of BUL practice in Case D (Private, Auto) is still not wholly explained by the length of employment of its top manager. Case D has an insider top manager with long-term employment so its top manager has a strong incentive to adopt embedded BUL practices. However, it only achieved a moderate level of BUL embeddedness. Therefore, more factors need to be analysed to explain this phenomenon.

5.4 Firm's Access to Capital

In this section, the level of a firm's access to capital will be analysed, to establish whether access to financial capital and human resource capital influences the top managers' capability to engage with innovations.

BUL requires involvement of knowledgeable employees into the innovation process, and continuous training to both managers and employees. Therefore, a firm's access to high quality human resource capital is important to have embedded BUL. Moreover, based on the experience from Case B (Local SOE, Auto) it is also very expensive to build a BUL system consisting of highly embedded BUL practices. Case B has all five BUL practices in place and all of them are highly embedded. They spent at least a million RMB to hire a professional, lean management consultancy firm from Japan to design their lean production system, including a proposal system using Kaizen programmes as instruments. In addition, the OA (office automation) system they used to manage their work-related records was developed by IBM for them, which is highly unlikely to be cheap. Moreover, every Saturday Case B provides intensive training for all its employees and managers. Although most of this training is delivered by internal trainers, so many training hours provided in-house would certainly not be delivered for free.

Therefore, whether or not a firm has access to capital could influence its capability to adopt embedded BUL practices.

In the following subsections, each case will be studied to discover how many forms of capital they have access to using the classification of capital developed based on work by Peng *et al.* (2005) and Yiu and Lau (2008). The forms of capital have been divided into two groups to include financial capital and human resource capital.

5.4.1 Good BUL embeddedness group

5.4.1.1 Case B (Local SOE, Auto)

Case B receives all types of capital except for the training on management knowledge for its managers.

Financial Capital

Easy Loan

The firms could very easily acquire loans from banks because they are one of the market leaders in the Chinese commercial vehicle sector. In addition, they are one of the core manufacturing companies in their city. Therefore, banks would like to lend money to them.

Tax relief

They also receive tax exemption on new products they launch in the first three years. Furthermore, because they export to over 80 countries, they receive tax refunds for their exports. Moreover, they get tax reductions on products that have received technological awards issued by government at varying levels.

Government purchase

Case B is the only producer of commercial vehicles in that region, therefore, nearly all buses in that city are produced by Case B.

Funding for R&D from government

Where Case B is jointly developing new energy vehicles with Tsinghua University, as previously mentioned, the central government provided them with research funding for 30 million RMB. Moreover, Case B received many forms of direct funding from different levels of governments that totalled over 170 million RMB in 2016.

Awards issued by authorities

As a key leader in the local economy, and a leader of China's commercial vehicle sector, Case B receives many awards from different levels of government every year. Recently, Case B received 2 City-level rewards for two new types of technological innovations used on their products.

Human Resource Capital

Technical training

Engineers in Case B receive some training from local universities because they have joint R&D programmes with them.

Human resources

Case B attracts a large number of highly talented engineers from all over China because the local government gives Case B an annual quota to help employees from other cities ("outsiders") to have local *Hukou* (local citizen residency). This is a very attractive thing to "outsiders" because it is very difficult for them to get *Hukou* in the city where Case B is located, this policy has attracted a large number of highly talented and skilled people to work for Case B.

5.4.1.2 Case C (Local SOE, Auto)

As with Case B, Case C receives all types of capital apart from management knowledge training for managers.

Financial Capital

Easy Loan

Case C could very easily acquire loans from banks because they are one of the market leaders in the local automobile sector. The VP states that "... all car related firms in this

province belong to us...At the beginning of every year, the branch managers of local banks will actively call me to ask how much money we would like to borrow this year ... [It is because] these managers ... have an annual quota of loans they have to give out to creditable customers ... [who] are mainly large SOEs like us ... (C-VP)”. Therefore, Case C has easy access to loans due to the vital role it plays in the local automobile sector.

Tax relief

Case C also benefits from tax exemption on new products launched in its initial three years like Case B. This is a national level policy so all firms in China are entitled to this, regardless of their ownership. Moreover, firms receive tax refunds for their exports as does Case B. Moreover, tax exemptions on new energy vehicles helps to attract more customers. Case C is a market leader in heavy duty trucks that run on natural gas, customers who buy their trucks are also exempt from paying Vehicle Purchase Tax. This is a nationwide policy of the central government.

Government purchase

As the only automobile firm in their province, the government gave them priority when purchasing trucks. However, because Case C does not produce coaches, the local buses are not produced by them. They mainly sell trucks and special utility trucks, like road cleaning vehicles to the local government.

Funding for R&D from the government

Case C has a national level research institute specialising in developing natural gas engine technology. In a recent R&D project initiated by China’s Ministry of Industry and

Information Technology, they received direct funding for 130 million RMB to develop natural gas engine technologies to improve fuel efficiency.

Awards issued by authorities

As a key driver in local economic growth, and a leader of China's natural gas heavy duty trucks, Case C receives many awards from different levels of government every year. Recently, Case C received a national level reward issued by the China Transportation Association for the significant contributions made to the express postal service in China. They received this award because Case C has developed an Internet of Things (IoT) system especially designed for organising freight transportation. The system was launched in 2011 and had been adopted by nearly all major express companies in China by 2016.

Human Resource Capital

Technical training

Engineers in Case C receive regular technical training from local universities. There is one local university that is highly specialised in automobile engineering and design, thus they formed strategic alliances with firms to regularly train their engineers, and also conduct joint R&D programmes on automobile technology.

Human resources

As the only firm in the local automobile sector, Case C attracts many high-quality university graduates with the university mentioned above who specialise in automobile engineering and design. They formed a partnership to give priority to the graduates of this university to work for Case C.

5.4.1.3 Good BUL embeddedness case group summary

Empirical evidence in this research shows that local SOEs receive high levels of capital from the government so they have easy access to financial capital through easy loans and direct funding for R&D projects. This allows them to adopt expensive BUL practices, given the fact that the top managers of the two local SOEs are insiders and both have the necessary incentive to adopt BUL practices. Also, as they have good access to human resource capital, their employees and managers have the capability of contributing ideas to BUL for innovation.

Table 5-3: Summary of capital received by good BUL embeddedness group

Forms of Capital		Case B	Case C
Financial Capital	Easy Loan	■	■
	Tax relief	■	■
	Government purchase	■	■
	Funding for R&D from government	■	■
	Awards issued by authorities	■	■
Human Resource Capital	Technical training	■	■
	Management knowledge	□	□
	Human resources	■	■

■ Have access to this form of capital □ Do not have access to this form of capital

5.4.2 Moderate BUL embeddedness group

5.4.2.1 Case D (Private, Auto)

Case D only has access to limited capital.

Financial Capital

Tax relief

Case D also receives tax exemption on new products launched in its initial three years like Case B and C. This is a national level policy so all firms in China are entitled to this regardless of ownership. Moreover, because Case D exports a great deal to foreign countries, including Germany, Italy, Switzerland, the United States and Southeast Asia, they receive tax refunds for their exports as in Cases B and C.

Awards issued by authorities

As one of the leading Chinese manufacturers producing fuel supplying parts for engines, like fuel injectors and high-pressure fuel pumps, Case D received many awards for their new products and innovations. Moreover, they have recently been issued a licence to supply products to firms in the defence sector. Because such licences are very difficult to obtain, especially for private firms, this licence could be considered as a certificate confirming their high product quality and reliability.

Apart from the awards issued for the products or technologies they developed, Case D also received a city level award for their innovation in using MS Office software to develop a customised OA system. However, this innovative utility of MS Office software is actually forced by their poor access to financial resources from banks. They spend most of the money renewing equipment, meaning they could not afford to adopt highly embedded BUL practices like Cases B and C have.

As listed above, Case D could only acquire a little capital from the government, a dramatically different experience from what is enjoyed by local SOEs as discussed in the previous sub-sections. This is because Case D lost the privilege to receive other forms of capital from the local government after becoming a private firm. They have especially poor access to financial capital from the easy loans that the SOEs would have. Their CEO

states that: “... [*When we were an SOE*] we were able to easily borrow money from local banks to expand our factory. However, as a private company it becomes more difficult now. ... *We can still get loans, but more difficult than before ...* (D-CEO)”.

Moreover, because the only local university does not have a good reputation in engineering, this causes two main issues. Firstly, they are unable to recruit high quality engineers locally for their R&D department. What is worse, because Case D is located in a poorly developed, small city, graduates from good universities are not willing to work for them. Moreover, even local people who graduated from good universities in other regions do not want to return to their home town and work for them. This is a major problem for Case D to employ a sustainable, high quality workforce.

In addition, because of the low capability of the local university, Case D cannot have joint R&D projects with them. It is also difficult for Case D to currently conduct joint R&D with public research institutes (PRIs). This is because a large number of PRIs in the field of fuel supply systems have been privatised and have become internal research institutes owned by large SOEs who have subsidiaries producing fuel supply products. Due to the competitive relationship between them, it is very hard for Case D to form any joint R&D project with those internal research institutes, especially Case D as it is now a private company.

Thus, Case D only receives very low levels of capital from the government. They have especially poor access to financial capital, which makes them unable to adopt embedded BUL practices. Based on the experiences of Case B these practices are very expensive. Having poor access to good quality human resource capital also constrains their capability to have high quality ideas from employees.

5.4.2.2 Case F (Central SOE, Railway)

Case F is a second-tier subsidiary of CRRC which is the only SOE owned by the central government. Therefore, all SOEs in China's railway sector are tier one subsidiaries of CRRC.

The level of capital that Case F receives is about the same as that of the local SOEs (Case B and C) in the automobile sector that is discussed in Section 5.4.1.

Financial capital

Easy Loans

Case F has easy access to bank loans because they are the sole supplier to some models of high speed trains that are widely used in China nowadays. Since they have a basically monopolistic position in their business, and they are a central SOE, banks do not doubt their ability to repay their loans. Case F built their current headquarters in a rural area around Beijing that was solely reliant on loans from local banks.

Tax relief

The new product developed by Case F is exempt from tax in its first three years. They also receive a tax reduction on products that have received technological rewards from the Ministries of Transportation and the Ministry of Industry and Information Technology.

Funding for R&D from the government

Case F was founded in 2003, ten years before the former China's Ministry of Railway was closed. Therefore, their parent company was directly owned by the ministry when

they were established. The mission of Case F has been to import and localise pantograph technologies from foreign companies. Moreover, they also needed to continue making improvements on the original design so that their products could be fitted on newer and faster high-speed trains developed indigenously by China North Rail (merged with China South Rail into CRRC) at that time. Thus, they receive a tremendous amount of funding from the former Ministry of Railways to carry out R&D. Although the Ministry of Railways has been reformed, Case F is still the leading company in the production of the pantograph and other related parts for high speed trains. Their newest model is capable of operating at a speed of 380 km/h.

Awards issued by authorities

As the leading firm in producing pantographs for high speed trains, they received many awards for the technological innovation they produced. For example, they received a Second-Class Railway Technology Award issued by the China Academy of Railway Sciences for their innovation to solve electrical shortages caused by the severe air pollution, called fine particle matter (PM_{2.5}), in many regions of China.

Case F does not benefit from government purchasing because their products cannot be used independently. Therefore, they are only a supplier for major high-speed train producers.

Human Resource Capital

Technical training

The engineers of Case F often attend meetings organised by the university relating to their system of railways – Beijing Jiaotong University. The parent company CRRC often

organises seminars and meetings to keep their subsidiaries up-to-date about new technologies that have been developed or imported, as well as recent market trends.

Human Resources

As a central SOE located in a highly developed tier 1 city (yixianchengshi), Case F is a very attractive employer especially given the fact that their parent company is CRRC. Being a subsidiary of CRRC means the welfare and salary provided by Case F is much higher than SOEs in other sectors. In addition, because Case F is classified as a “high-tech” company, local government allows their employees to have priorities when applying for *Hukou*. This privilege is very similar to that enjoyed by Case B employees. Therefore, this allows Case F to hire many talented engineers for their R&D department.

To conclude, Case F receives a high level of capital from the government. They could afford to adopt embedded BUL practices because they have easy access to financial resources through loans.

5.4.2.3 Case G (Central SOE, Railway)

Financial capital

Easy loans

Although Case G does not often borrow from the banks, they have easy access to loans from local banks. It is because they have special status being a central SOE in a small city. The city where Case G is located has two central SOEs in the railway sector. They are Case G, and the parent company of Case G, which is a large central SOE. Therefore, Case G could easily secure loans with the endorsement of their parent company.

Tax relief

Like all other cases discussed above, they enjoy tax exemption for new products for three years. Because this is a national policy since 1984, every company has this. Apart from this, no other tax relief policy was agreed by the local government.

Awards issued by authorities

As the only supplier of train couplers for heavy duty freight trains, Case G has received some awards for the technological problems they've solved to meet customer needs. For example, one model of their range of couplers used to have a malfunction issue when locomotives pushed coaches from the rear. After they worked closely with CARS they have modified the design of the coupler to avoid this problem. The modification has been awarded a Third-Class Railway Technology Award by CARS.

Human Resource Capital

Technical training

Similar to Case F, Case G also needs to send engineers to attend seminars and meetings organised by CRRC and Beijing Jiaotong University to learn new technological developments and new trends in the market.

Human resources

As a central SOE in a small city, Case G is a very attractive employer who can provide good salaries and high job security. However, Case G cannot find highly skilled engineers locally because the city is too small for them to stay. Fortunately, because Case G is a small company, they only need to recruit about one person every two or three years. Therefore, they do not currently face severe human resource problems.

To sum up, Case G does not receive as much capital from the government as other SOEs. This is mainly due to the size of their firm, and they do not have production plants which usually have much higher overheads. However, the level of capital provided by the government to Case F is still significantly higher than what Case D (Private, Auto) could achieve. Therefore, the level of capital Case F receives from the government is considered as high in this thesis.

5.4.2.4 Moderate BUL embeddedness case group summary

Amongst firms with moderate levels of embedded BUL practices, Case D (Private, Auto) has low levels of access to capital. Its level is significantly lower than what central SOEs could have, regardless of how small the central SOEs (like Case G, Railway). The limited access to capital considerably constrains its capability to adopt all embedded BUL practices like Case B (Local SOE, Auto) even though it has an insider top manager with long-term employment.

However, Case D (Private, Auto) found some ways to avoid adopting expensive BUL practices by developing them in-house. For example, they developed an online proposal and record keeping system using Microsoft Office software. This allows them to have some embedded BUL practices without a large amount of financial investment. This finding explains the moderate BUL embeddedness of Case D.

Findings from the analysis of moderate BUL embeddedness case group is summarised in Table 5-4

Table 5-4: Summary of capital received by moderate BUL embeddedness group

Forms of Capital		Case D	Case F	Case G
Financial Capital	Easy Loan	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Tax relief	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Government purchase	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Funding for R&D from government	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	Awards issued by authorities	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Human Resource Capital	Technical training	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Management knowledge	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Human resources	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

■ Have access to this form of capital □ Do not have access to this form of capital

5.4.3 Poor BUL embeddedness group

5.4.3.1 Case A (Central SOE, Auto)

Financial capital

Easy loans

Case A is a large central company that produces high speed engines for special vehicles and ships. It is the only SOE in the automobile sector in their city. Moreover, because their products are widely used by the army and navy, they have an especially high status in the local economy. This allows them to have easy access to loans from local banks. In fact, most of their new equipment is purchased with loans. Therefore, their equipment is frequently renewed.

Tax relief

Apart from the regular three years exemption of tax for new products, which is commonly available to all firms, Case A is entitled to a special tax exemption policy that is very different from the other six cases. Because the central government has issued a tax

exemption policy to military products in 1994, most products of Case A are exempt from paying tax for an unlimited period.

Government purchase

The main customer of Case A is China's armed forces. Case A has been assigned military representatives to work in their company to monitor product quality and production progress.

Funding for R&D from the government

Because Case A produces military products, the details of funding provided by the government are confidential. Therefore, it will not be discussed here. However, it was confirmed by the Chief Engineer of Case A that their R&D projects are heavily funded by the government.

Awards issued by authorities

As the leading firm in producing military use high speed engines, Case A has received many awards from government agencies and industrial associations. For example, they have recently been awarded a Second Class National Science and Technology Progress Award by the State Council.

Human Resource Capital

Technical training

The Industrial Association of Internal Combustion Engines often organises workshops to teach new technology, regulations and policies to firms. During the data collection period in China, the researcher was invited by Case A to attend one three-day workshop being

organised by the industrial association and hosted by the Beijing Institute of Technology. There they discussed cutting edge technologies developed in the international market, technologies recently developed by Chinese firms, changes to regulations regarding new emission standards, forecasting the direction of the engine sector for the next few years, and so on.

Human resources

Because Case A is the only firm who specialises in producing high speed diesel engines for military vehicles and ships, they attract a lot of graduates with relevant degrees from universities all over China. Case A has formed a partnership with a university who specialises in developing engine technologies to give priority to their graduates when they apply for jobs in Case A.

To sum up, Case A receives a high level of capital so they have easy access to financial resources. Therefore, they are able to afford to adopt embedded BUL practices.

5.4.3.2 Case E (Central SOE, Railway)

Financial capital

Easy Loans

Case E is the leading manufacturer of electric locomotives for heavy duty freight trains. It is a tier 1 subsidiary under CRRC. As a large SOE in a small city, they are one of the main manufacturing companies in that region. Therefore, local banks give them preferential policies when issuing loans. They use loans to conduct some of their R&D and purchase new, more advanced equipment.

Tax relief

As in other cases cited, Case E enjoys tax exemption for its new products for three years. Apart from this, they do not have other tax relief benefits.

Government purchases

Because the railway transportation service is controlled by the China Railway Corporation (CRC), a central SOE, they are the main customer of Case E. It is a newly formed company after the former Ministry of Railways was disbanded. Therefore, this company used to be part of the ministry, and as such, CRC used to be part of the central government.

Funding for R&D from the government

As a leading manufacturer of locomotives for heavy duty freight trains, they are heavily funded to develop products based on plans made by CRRC. For example, they have completed two major projects that started in 2004 and, until recently, were developing two models of heavy duty locomotives to export to a country in Europe where the average temperature is very low during winter. Low temperatures have a significant impact on the reliability of locomotives, even world leading railway equipment manufacturers SIEMENS and Alstom have failed in this project. Case E has worked closely with universities and PRIs, and spent at least 1.5 billion RMB on these two projects. Most of the research funding was provided by CRRC and loans were issued by The Export-Import Bank of China⁶.

Awards issued by authorities

⁶The Export-Import Bank of China is directly owned and managed by the State Council of China to provide financial support to foreign countries to promote the export of China's products and services. (<http://english.eximbank.gov.cn>).

Case E has received many awards for their products and technologies developed indigenously. For instance, the two projects mentioned previously, were awarded a Second-Class Railway Technology Award issued by the China Academy of Railway Sciences.

Human Resource Capital

Technical training

Similar to Cases F and G, Case E also needs to send engineers to attend seminars and meetings organised by the CRRC and Beijing Jiaotong University to learn new technological developments and new trends in the market.

Human resources

Case E is a large central SOE located in a small city so it is a very attractive employer in the local labour market. A lot of native people who have gone to universities in other cities to gain degrees in railway-related fields choose to return and work for Case E. Therefore, they have a good source of human resource from the local labour market.

To sum up, Case E receives a high level of capital from the government as do other SOEs studied in this thesis.

5.4.3.3 Poor BUL embeddedness case group summary

Empirical evidence in this research shows that central SOEs receive high levels of capital from the government. They have especially easy access to financial capital through easy loans and direct funding on R&D projects. This makes them able to afford to adopt embedded BUL practices. However, Case A (Central SOE, Auto) and Case E (Central SOE, Railway) only have poor BUL embeddedness. This could not be justified by their

high levels of access to capital. Therefore, more factors need to be considered together to explain this finding.

Findings from analysis of poor BUL embeddedness case group is summarised in Table 5-5

Table 5-5: Summary of capital received by poor BUL embeddedness group

Forms of Capital		Case A	Case E
Financial Capital	Easy Loan	■	■
	Tax relief	■	■
	Government purchase	■	■
	Funding for R&D from government	■	■
	Awards issued by authorities	■	■
Human Resource Capital	Technical training	■	■
	Management knowledge	□	□
	Human resources	■	■

■ Have access to this form of capital □ Do not have access to this form of capital

5.4.4 Summary of findings on a firm's access to capital

From previous analysis on the level of capital each case received from the government, several findings are summarised in Table 5-6.

Table 5-6: Summary of findings on firm's access to capital

	Embeddedness of BUL practices	Firm's access to capital	Ownership
B	Good	High	Local
C	Good	High	Local
D	Moderate	Low	Private
F	Moderate	High	Central
G	Moderate	High	Central
E	Poor	High	Central
A	Poor	High	Central

Rows in grey cannot alone be explained by findings in this section.

Firstly, the private firm (Case D, Auto) only received a low level of capital from the government. They have especially poor access to financial resources through loans. In addition, they could not form a joint R&D situation with local universities and PRIs because the local university does not have good levels of engineering studies, and PRIs in this field have mostly been transformed into internal research institutes owned by their competitors (subsidiaries of large SOEs).

Having poor access to financial resources could be the key explanation as to why Case D only has moderate levels of embedded BUL practices, even though they have an insider top manager for the long term, and he has a strong incentive to adopt BUL practices. Because highly embedded BUL practices are expensive to have according to the experience of Case B, lack of financial resources limited Case D's capability to adopt embedded BUL practices. In short, Case D could not afford them.

Secondly, empirical evidence in this research shows that central SOEs and local SOEs receive nearly all forms of capital in both financial capital and human resource capital. This allows them to have the capability to afford having embedded BUL practice and to expect good suggestions from knowledgeable workforce.

However, only local SOEs have achieved good BUL embeddedness. It suggests that other factors need to be considered together to explain these results.

From Section 5.2 and Section 5.3, empirical evidence shows that all four central SOEs that have been studied have outsider top managers on short-term employment. This could partly explain why central SOEs have lower levels of BUL embeddedness than local SOEs and private firms who have insider top managers with long term employment.

Because outsider top managers have no firm-specific knowledge needed to observe and appreciate low-visibility BUL activities and tend to only plan for short-term development of the firm's innovation capability, they do not have the incentive to adopt embedded BUL practices.

However, this explanation could only explain the poor BUL embeddedness of Case A (Central SOE, Auto) and Case E (Central SOE, Railway), but fails to explain the moderate BUL embeddedness of Cases F and G (Central SOEs, Railway).

Therefore, more factors need to be added to the original framework to fully explain the research findings. This additional factor is that of market competition which emerged during the data analysis. This factor will be analysed in the next section.

5.5 Market Competition

Whilst performing the data analysis, it was noted that the original three institutional factors could not sufficiently explain the findings of the research. Empirical evidence from interview data shows that the level of market competition, that a firm faces has a crucial impact on its level of BUL embeddedness. Therefore, the fourth institutional factor is added to the original framework to fully explain the research findings.

The following sub-sections will analyse the impact of market competition on the level of BUL embeddedness of firms using group-case analysis.

5.5.1 Good embeddedness BUL group

5.5.1.1 Case B and C (Local SOEs, Auto)

Case B faces intense competition from domestic competitors. This is because there are a large number of provinces in China that have government owned manufacturers of

commercial vehicles. Therefore, those local SOEs are competing with one another in the domestic market. Apart from domestic competition, Case B also faces many threats from foreign firms in the international market. This is because Case B has established an assembly plant in 20 countries and exports to over 80 countries.

Therefore, the top manager of Case B is under pressure to address threats from its rivals by improving its innovation capability through the adoption of embedded BUL practices.

5.5.1.2 Case C (Local SOEs, Auto)

Case C faces intense competition in the domestic market as there are many other large commercial vehicle manufacturers, who also are local SOEs, owned by other city or provincial governments. In fact, Case B (Local SOE, Auto) is one of their largest domestic competitors. They do not face many threats directly from foreign rivals in the domestic market because the Chinese government considers the technologies of heavy duty trucks as strategic and provides special applications to military vehicles. Therefore, the central government maintains strategic control on how much of the market is open to foreign manufacturers to protect its domestic firms. Foreign firms can only enter the Chinese market by forming minority shareholding (foreign firms hold less than 50%) JVs with Chinese SOEs to enable technology transfer and spill over.

However, because Case C has established 4 FDI factories overseas and they export to Europe, Africa, Asian and Middle-eastern countries. They face a high level of competition from foreign manufacturers in the international market. Therefore, the top manager of Case C has to address the threats from both domestic and international rivals in order to survive.

To conclude, the top manager in Case C is under pressure to address threats from rivals in both the domestic and international markets. Therefore, the top manager of Case C has a high level of incentive to adopt embedded BUL practices.

5.5.1.3 Good BUL embeddedness case group summary

Empirical evidence in this research shows that local SOEs face intense competition from both domestic and international competitors, so top managers of local SOEs have to adopt embedded BUL practices to develop the innovation capability of their firms. Therefore, local SOEs have the highest level of BUL embeddedness.

5.5.2 Moderate embeddedness BUL group

5.5.2.1 Case D (Private, Auto)

Case D also faces intensive competition in the domestic market and international markets. This is because the market of parts for fuel supply systems for engines is completely open to market competition. Most firms are private right from their inception or were privatised from SOEs nearly a decade ago. The others are subsidiaries of large SOEs who produce entire vehicles. The CEO of Case D states that: *“I think a big challenge to our product innovation is severe imitation and price competition from local competitors. ... A few weeks after we launch some new products ... [some competitors] will release a near identical product at a lower price. ... (D-CEO)”*.

What is more, the central government allows foreign manufacturers to freely enter this market through exports and FDIs. For example, Robert Bosch GmbH is the world’s leading manufacturer of parts for fuel supply system for engines. They formed a majority shareholding (where the foreign firms hold more than 50%) JV with a Chinese fuel

injector factory in Wuxi, Jiangsu Province, to produce some products locally in China in 2005. Bosch is one of the main foreign competitors to Case D in the domestic market.

Therefore, Case D faces intense competition not only from domestic competitors, but it also faces a direct threat from the world's leading foreign rivals in the domestic market. This forces Case D to adopt embedded BUL practices to improve their innovation capability. However, as found before in Section 5.4.2.1, limited access to capital constrains the capability of Case D to adopt a large number of embedded BUL practices, which require a significant amount of financial investment. Such financial constraints mean that Case D has only moderate BUL embeddedness.

5.5.2.2 Case F (Central SOE, Railway)

Case F produces pantographs specifically to fit to some models of high speed trains that are produced in China. At the time they were established, they had only one competitor. However, some railway equipment manufactures in China started to enter into this market in recent years by licencing technologies from foreign firms. The CEO of Case F states that: “... *These new firms grow quickly as they simply licence ready-made technologies and import turnkey factories. ... Because a pantograph is a modularised part on high speed trains, our products could potentially be abandoned by train manufacturers ...* (F-CEO)”. Thus, the top manager of Case F has had to adopt some BUL practices to develop their innovation capability and to maintain their market share by adopting embedded BUL practices.

5.5.2.3 Case G (Central SOE, Railway)

Case G produces couplers that are specially used on some models of trains. These models of trains are mainly used for freight transportation, therefore, couplers on trains need to

be extremely durable and reliable. They do not face intense competition in the domestic market as they have very stable customers who purchase the trains.

Nevertheless, they still face some degree of competition because couplers of trains are highly modularised parts, therefore, they could easily be replaced by newer models if necessary. In fact, there are already some subsidiaries under CRRC who have started to licence coupler technologies from foreign companies. Most of their products are used on passenger trains that are much more light-duty than what are produced by Case G for freight trains. However, once the plan of CRRC changes to allow those subsidiaries to produce new models of couplers, Case G could very easily lose its market share.

Like the situation of Case F (Central SOE, Railway), Case G started to face emerging competition from subsidiaries of other central SOEs. Thus, the top manager has had to introduce some embedded BUL practices to develop an innovation capability through adopting embedded BUL practices to maintain their market share.

5.5.2.4 Moderate BUL embeddedness case group summary

Empirical evidence in this research shows that private firms face intense competition in the domestic market. Threats from rivals encourage the top managers of private firms to adopt embedded BUL practices to develop innovation capability and to defend their market share. However, this research finds that private firms have limited access to capital making them incapable of adopting a large number of embedded BUL practices. Therefore, they could only attain moderate BUL embeddedness.

This research also finds that some of the central SOEs are facing some degree of competition in the domestic market. Although their top managers are outsiders with short-term employment, the top managers are under pressures from competitors in the domestic

market. Therefore, the top managers in those central SOEs decided to adopt some embedded BUL practice to improve their innovation capability.

5.5.3 Poor embeddedness BUL group

5.5.3.1 Case A (Central SOE, Auto)

Case A faces almost no competition in the domestic market. Case A is by far the oldest and most specialised company amongst very few suppliers of high-speed diesel engines for the Chinese defence sector. Their products are widely used on heavy duty trucks, ships, emergency generators and special vehicles in both the defence and civil-use markets. Because their products are mainly used for military vehicles and ships, they have almost total monopoly in this business meaning they have little or no competition in the domestic market.

Therefore, the top manager does not have to adopt BUL practices to maintain the competitiveness of the firm. Especially given that embedded BUL practices are costly and require a long period of time before the outsider manager of Case A might observe the benefits of BUL on improving the innovation capability of the firm. Thus, his incentive to adopt embedded BUL practices is low.

5.5.3.2 Case E (Central SOE, Railway)

Case E faces little competition from the domestic market. Case E specialises in producing high power electric locomotives for freight transportation. Only a very limited number of subsidiaries of CRRC are capable of producing such heavy-duty locomotives. Others produce mainly passenger trains that are comparatively much easier to produce. Therefore, Case E faces little competition in domestic market.

Therefore, the top manager in Case E does not have to improve his innovation capability to survive in the market, so the level of his incentive to adopt BUL practice is low.

5.5.3.3 Poor BUL embeddedness case group summary

Empirical evidence in this research shows that the level of incentive of top managers in some central SOEs is low because they do not face any competition. It is found that Case A (Central SOE, Auto) and Case E (Central SOE, Railway) enjoy having almost total monopoly in their fields of business means neither face any competition in the domestic market.

Because some SOEs barely face any competition, the top managers in those central SOEs do not have to adopt BUL practices to maintain the competitiveness of their firms. Especially given that embedded BUL practices are costly and require a long period of time before the outsider manager of the central SOEs observes the benefits of BUL on improving the innovation capability of firm. This finding explains why all four central SOEs studied have outsider top managers with short-term employment, and have access to high levels of capital, showing two different levels of BUL embeddedness.

The central SOEs with poor BUL embeddedness do not face competition, while the central SOEs with moderate BUL embeddedness face some degree of competition.

5.5.4 Summary of findings on market competition

From the analysis of the impact of market competition on the level of BUL embeddedness of firms, the findings are summarised in Table 5-1.

Firstly, empirical evidence in this research shows that local SOEs and private firms face intense competition in the domestic market. Threats from rivals force the top managers of those firms to improve their innovation capability by adopting embedded BUL

practices making them capable of defending their market share. Moreover, they could maintain their competitive advantage and generate a better economic performance. Therefore, local SOEs could have good BUL embeddedness.

Table 5-7: Summary of findings on market competition

Case	Case group	Ownership and sector	Level of Market competition
B	Good	Local, Auto	High
C	Good	Local, Auto	High
D	Moderate	Private, Auto	High
F	Moderate	Central, Railway	Moderate
G	Moderate	Central, Railway	Moderate
A	Poor	Central, Auto	Low
E	Poor	Central, Railway	Low

Row in grey could not be explained by findings in this section. So require further analysis.

However, the intense market competition factor could not explain the moderate BUL embeddedness of Case D (Private, Auto). This must be combined with the fact that Case D has limited access to capital, making them unable to afford having several embedded BUL practices even though its top manager has the incentive to do so.

Secondly, empirical evidence in this research shows that central SOEs do not face intense market competition in the domestic market so they do not have to adopt BUL practices to maintain the competitiveness of their firms. Especially given that embedded BUL practices are costly and require a long period of time before the outsider manager of any central SOEs observes the benefit of BUL on improving the innovation capability of firm. This finding explains why all four central SOEs studied have outsider top managers with short-term employment, and have access to high levels of capital, showing two different levels of BUL embeddedness.

The central SOEs with poor BUL embeddedness do not face competition, while the central SOEs with moderate BUL embeddedness face some degree of competition.

These two findings suggest that to fully explain the current level of BUL embeddedness, the four institutional factors within China's NSI should be simultaneously considered. Failing to include any one of them would prevent a full explanation being developed for a firm's level of BUL embeddedness from China's NSI perspective.

5.6 Chapter Conclusion

This chapter studies the impact of four institutional factors within China's NSI on the level of BUL embeddedness of firms. The four factors are: 1) whether the top manager of a firm is an insider or an outsider, 2) the length of employment of the top manager, 3) the firm's access to capital. The fourth institutional factor is found during data analysis which is the market competition.

As already mentioned in the introduction of this chapter, three assumptions are made in this research based on extensive literature (see Section 2.5.3). The three assumptions justify why firms should adopt BUL to develop innovation, why BUL requires long-term planning by top managers, and why BUL requires top managers to have firm-specific knowledge. The three assumptions are developed from the literature so they are theoretically justified.

a) **BUL leads to improved innovation capability and better innovation performance, which consequently leads to improved economic performance.**

--- Thus, top managers of firms will adapt BUL practices if they want to have good innovation along with improved economic performance.

b) **BUL practices require long term investment before their benefits can be perceived in terms of better innovation capability or performance.** --- Thus,

top managers who will only remain in their position for 4-5 years are less likely

to adopt embedded BUL practices, as they could not anticipate the benefit of those practices within their period of employment.

- c) **BUL is more difficult as it is less visible to top managers who do not have firm-specific knowledge. It is because BUL tends to occur amongst employees on a daily basis.** --- Thus, outsiders who do not have sufficient firm-specific knowledge are less likely to have an awareness of the BUL activities taking place on the shop floor. Even if they noticed such learning activities, they would not adopt BUL practices or facilitate them as they are unaware of the benefits of such learning effects.

Table 5-8: Cross case comparison of the impact of NSI and ownership on managerial decisions to use BUL

Case	Ownership	Insider vs outsider as top manager	Capital	Long or Short term top manager	Market competition	Embeddedness of BUL
B	Local	Insider	High	Long-term	High	Good
C	Local	Insider	High	Long-term	High	Good
D	Private	Insider	Low	Long-term	High	Moderate
F	Central	Outsider	High	Short-term	Mid	Moderate
G	Central	Outsider	High	Short-term	Mid	Moderate
A	Central	Outsider	High	Short-term	Low	Poor
E	Central	Outsider	High	Short-term	Low	Poor

With the three assumptions in mind, the empirical evidence in this research shows that:

Firstly, local SOEs have insiders as a top manager so they have firm-specific knowledge to observe and appreciate BUL efforts at shop floor level. Moreover, top managers have high level incentives to adopt BUL practices because they have long term employment as the top manager, and they plan for the long term development of the firm's innovation capability. In addition, local SOEs face intense competition in the domestic and international markets so top managers of firms must address threats from rivals to defend

their market share. Lastly, local SOEs are wealthy as they receive high levels of capital from local government, especially financial resources through easy loans. Therefore, local SOEs could afford to adopt embedded BUL practices.

Secondly, private firms have insiders as top managers as well, so they could observe and appreciate BUL effects at shop floor level. Moreover, the level of the top manager's incentive to adopt BUL is high because the top managers are selected for long term employment and they face intense market competition even more seriously than local SOEs. However, private firms have poor access to financial resources because the local government does not provide them with many forms of capital. Therefore, their BUL embeddedness is only at moderate level as they could not afford to adopt embedded BUL practices even though their top managers are insiders and have a strong incentive to do so.

Thirdly, central SOEs receive high levels of capital provided by the government, especially financial resources through easy loans. This allows them to adopt embedded BUL practices. However, the government only appoints outsiders as top managers of firms so top managers do not have sufficient, firm-specific knowledge to observe and appreciate BUL effects at shop floor level. Moreover, the level of top managers' incentives to adopt BUL practices is low because they are only appointed for a short term of around 5 years, so they do not need to plan for the long-term development of their firm's innovation capability. What is more, some central SOEs do not face market competition, so they do not have to innovate to address threats from rivals. Therefore, even though central SOEs have financial resources to afford to have embedded BUL practices, they do not do so because the top managers are incapable of observing and appreciating BUL effects, and they do not have any incentive.

Fourthly, exceptions amongst central SOEs exist where there is a moderate level of embedded BUL practices. It is mainly because these central SOEs face some degree of competition in the market even though they have outsiders as top managers for the short term. Top managers have to adopt at least some BUL practices to compete with rivals in innovations. Therefore, central SOEs could have a moderate level of embedded BUL practices when they face competition.

These four patterns of combination of institutional factors (summarised in BUL leads to **improved innovation capability and better innovation performance, which consequently leads to improved economic performance.** --- Thus, top managers of firms will adapt BUL practices if they want to have good innovation along with improved economic performance.

- d) **BUL practices require long term investment before their benefits can be perceived in terms of better innovation capability or performance.** --- Thus, top managers who will only remain in their position for 4-5 years are less likely to adopt embedded BUL practices, as they could not anticipate the benefit of those practices within their period of employment.
- e) **BUL is more difficult as it is less visible to top managers who do not have firm-specific knowledge. It is because BUL tends to occur amongst employees on a daily basis.** --- Thus, outsiders who do not have sufficient firm-specific knowledge are less likely to have an awareness of the BUL activities taking place on the shop floor. Even if they noticed such learning activities, they would not adopt BUL practices or facilitate them as they are unaware of the benefits of such learning effects.

Table 5-8) suggest that to fully explain the current level of BUL embeddedness, the four institutional factors within China's NSI should be simultaneously considered. Failing to include any one of them would prevent a full explanation being developed for a firm's level of BUL embeddedness from China's NSI perspective.

The next chapter concludes this research by discussing research findings from Chapters 5 and Chapter 6 in the context of the literature to contribute to current knowledge.

Chapter 6: DISCUSSION AND CONCLUSION OF RESEARCH

6.1 Introduction

This research took the critical realism epistemology stance to formulate causal-explanations of the impact of three sets of institutions of China's national system of innovation (NSI) on bottom-up learning (BUL) activities in firms. To do this, this research used the multiple-case study method to analyse and evaluate how corporate governance, a firm's access to capital and market competition influenced the firms' adoption of BUL practices in seven Chinese firms including four central SOEs, two local SOEs and one private limited firm in China's commercial vehicle sector and railway equipment sector.

This chapter will discuss the key findings of this research and conclude this research as follows: Section 6.3 discusses the key research findings. Section 6.4 discusses contributions of this research to theories and practices. Moreover, an updated conceptual framework is developed based on the empirical findings. Section 6.5 acknowledges the limitations of this research and gives recommendations for future research directions.

6.2 Summary of Research Design

Based on NSI theory, innovation activities of firms are a social phenomenon shaped by their institutional environment. Therefore, this research is a causal-explanatory research aiming to investigate the underlying causal mechanism of that social phenomenon. The author took the critical realism epistemology stance believing the reality is stratified and that knowledge can be developed from investigating the underlying causal mechanism of the phenomenon by answering how and why questions. The multiple case study method was chosen to develop theories from cases.

This research is based on qualitative data collected from 37 in-depth semi-structured interviews with interviewees from seven companies between late 2015 and early 2016. Interviews were mainly high and mid-level managers in charge of R&D, quality management and HRM. These interviewees were chosen because they have sufficient knowledge of the firm's management practices including its BUL practice to provide appropriate information needed to answer the research questions. Some employees were also interviewed when possible to triangulate information given by managers. Interviews with several managers in a firm also served the purpose of triangulating the information provided by them. Moreover, some employees have been interviewed to triangulate information provided by the managers. Cases included four central SOEs, two local SOEs, and one private limited firm. Four cases are in automobile sector, and three cases in railway equipment sector.

The research questions are addressed using cross-case and group-case analysis. The next section will discuss how research questions are addressed respectively.

6.3 Research Aim and Discussion of Key Research Findings

This research aimed to understand the impact of China's NSI on BUL activities in firms. To attain this objective, this research studied how China's corporate governance system, the firm's access to capital, and sectoral openness to competition influence a firm's adoption of BUL practices. This objective has been further translated into three research questions. Each research question will be addressed with findings in this research in the following paragraphs.

Addressing research question one - "Do China's firms have bottom-up learning (BUL) practices to develop their innovation capability, and how embedded are BUL practices?"

Empirical evidence in this research shows that China's firms have various BUL practices. This research identified five main types of BUL practices adopted by seven cases studied, namely a proposal system, a problem-solving mechanism, work-related record keeping, internal training and job rotation. The findings indicate that China's firms have BUL.

Moreover, empirical evidence shows that the level of BUL embeddedness of China's firms varies significantly.

The level of BUL embeddedness is a relative measure of how many embedded BUL practices have been adopted by cases in comparison to others. Three levels of ratings are given to those cases studied: good BUL embeddedness, moderate BUL embeddedness, and poor BUL embeddedness.

In this research, an embedded BUL practice means that the practice is effective and thus helps the firm facilitate BUL activities. Not embedded BUL practices are not effective in facilitating BUL activities, so they only exist on paper. Whether a BUL practice is embedded or not is evaluated based on criteria developed using existing literature. (See Section 3.6.1.1)

Addressing the research question two – “How the level of firms’ BUL embeddedness varies amongst firms with different ownership?”

Empirical evidence shows that the level of BUL embeddedness varies amongst China's firms with different ownership.

This research found that local SOEs have good BUL embeddedness. The private firm has moderate BUL embeddedness. Some central SOEs have moderate BUL embeddedness, while some of them only have poor BUL embeddedness.

Empirical evidence in this research shows that local SOEs have good BUL embeddedness as they have the highest number of embedded BUL practices across the seven cases in focus. The private firm has only moderate BUL embeddedness because it has only adopted some of BUL practices. Interestingly, amongst the four central SOEs studied, two of them have moderate BUL embeddedness as they have some embedded BUL practices; while the other two central SOEs have only poor BUL embeddedness.

Further analysis in Chapter 6 reveals that the differences in the level of BUL embeddedness amongst the seven cases studied are caused by different combinations of corporate governance, the firm's access to capital and market competition factors that each case faces. This will be discussed subsequently.

Addressing research question three – “How does China’s corporate governance system and firms’ access to capital influence the adoption of embedded BUL practices in firms?”

Synthesised from existing literature, three institutional factors have been identified to study and explain how China’s corporate governance system and firms’ access to capital influences the level of BUL embeddedness in firms, namely 1) whether the top manager is an insider or an outsider, 2) whether the length of employment of the top manager is short-term or long-term, and 3) the level of a firm’s access to capital.

These three factors could explain why local SOEs have good BUL embeddedness but some central SOEs only have poor BUL embeddedness. It is because local SOEs have insider top managers for long-term employment but central SOEs have outsider top managers for the short-term. Therefore, top managers in local SOEs plan for long-term development of firms’ innovation capability though adopting a large number of

embedded BUL practices. On the contrary top managers in some central SOEs only plan for short-term development of innovation capability so have fewer embedded BUL practices.

However, these three factors could not explain why some central SOEs having outsider top managers with short-term employment and having good access to capital have moderate BUL embeddedness.

Whilst performing the data analysis, it was noted that the three institutional factors could not sufficiently explain the findings from the research. Empirical evidence shows that the level of market competition that a firm faces has a crucial impact on its level of BUL embeddedness. Therefore, the fourth institutional factor is added to the original framework developed from previous literature to fully explain the research findings.

Empirical findings in this research identified four patterns of how different combinations of the four institutional factors influenced the level of BUL embeddedness.

The first pattern is that firms with an insider as the top manager, having a top manager with long-term employment, having access to high levels of capital, and facing intense competition in the domestic market, have good BUL embeddedness. (See Table 6-1)

Table 6-1: Combination of institutional factors led to good BUL embeddedness

Good BUL embeddedness	Insider top manager
	Long-term employment of top manager
	High level of access to capital
	Facing intense market competition

This is the combination of institutional factors faced by local SOEs, so they have the highest level of BUL embeddedness amongst seven cases. The reasons are four-fold. First,

local SOEs have an insider as their top manager, so they have the firm-specific knowledge to observe and appreciate BUL effects at shop floor level. Second, top managers have a high level of incentives to adapt BUL practices because they have long-term employment as the top manager, and they plan for long-term development of the firm’s innovation capability. Third, local SOEs have the financial capability to adopt embedded BUL practices as they receive a high level of capital from local government, especially financial resources through easy loans. Fourth, local SOEs face intense competition in the domestic and international market, so top managers of firms have to address threats from rivals to defend their market share. Therefore, local SOEs are able to afford to adopt embedded BUL practices.

The second pattern is that firms with an outsider as top manager, having short term employment of the top manager, facing no competition in the domestic market, and having high access to capital, have poor BUL embeddedness. (See Table 6-2)

Table 6-2: Combination of institutional factors led to Poor BUL embeddedness

Poor BUL embeddedness	Outsider top manager
	Short-term employment of top manager
	High level access to capital
	Facing no market competition

This is the combination of institutional factors faced by two central SOEs. Their poor BUL embeddedness can be explained by three reasons. First, this research shows that central government only appoints outsiders as top managers of central SOEs, so top managers do not have sufficient firm-specific knowledge to observe and appreciate BUL effects at shop floor. Second, the top managers in central SOEs are only appointed for a short-term of around five years, so they do not need to plan for long-term development

of the firm’s innovation capability. Thus, they lack the incentive to adopt BUL practices. Third, these two central SOEs do not face market competition, so they do not have to innovate anything to address threats from rivals.

Therefore, although the two central SOEs have good access to capital, they do not have many embedded BUL practices because the top managers are incapable of observing and appreciating BUL effects due to a lack of firm-specific knowledge, and they do not offer incentives. The top managers in central SOEs do not have incentives to adopt embedded BUL practices because firstly, top managers are not concerned with the long-term performance of the firm as they have short-term employment; and secondly, they are not under pressure from competition.

However, two central SOEs studied in this research have moderate BUL embeddedness. These two cases show the third pattern of how the combination of institutional factors influence a firm’s BUL embeddedness.

The third pattern is that firms with an outsider as the top manager, having short-term employment of the top manager, and having access to high levels of capital, but facing some degree of competition in the domestic market, have moderate BUL embeddedness.

Table 6-3: Combination of institutional factors led to Moderate BUL embeddedness

Moderate BUL embeddedness	Outsider top manager
	Short-term employment of top manager
	High level of access to capital
	Facing some market competition

This is the combination of institutional factors faced by another two central SOEs. The reason why they might have a moderate level of BUL embeddedness is that they face

some degree of competition in the domestic market. Although the top manager of these two central SOEs are outsiders and have short term appointments, they are forced to have some embedded BUL practices to develop their innovation capability to defend their market share. Competition in the domestic arena contributes to the increasing of top managers' incentives to adopt embedded BUL practices. Therefore, they could have a moderate level of BUL embeddedness.

The fourth pattern that emerges shows firms with an insider as the top manager, having long-term employment of their top manager, facing intense competition from the domestic market, but having low access to capital, has moderate BUL embeddedness.

Table 6-4: Combination of institutional factors led to Moderate BUL embeddedness

Moderate BUL embeddedness	Insider top manager
	Long-term employment of top manager
	Low level of access to capital
	Facing intense market competition

Amongst the seven cases studied, only the private firm has poor access to financial resources. Therefore, its BUL embeddedness is only at a moderate level as it could not afford to adopt embedded BUL practices even though its top manager is an insider and has a strong incentive to do so. Professionally designed BUL practices are very expensive based on the experiences of Cases B and C (Local SOEs, Auto). However, Case D (Private, Auto) found some ways to avoid adopting expensive BUL practices by developing them in-house. For example, it developed an online proposal and record keeping system using Microsoft Office software. This allows the firm to have some embedded BUL practices without a great deal of financial investment. However, having

limited access to capital still limits their capacity to invest in other BUL practices such as internal training, which also requires a heavy investment in finance and labour.

These results lead to some interesting insights.

First, this research has empirically proved that China's NSI is not inconsistent with BUL activities in firms. In addition, firms design their BUL practices in different ways, so the level of embeddedness of BUL practices varies amongst firms.

It is found in this research that in general local SOEs and private firms have better BUL embeddedness than central SOEs. This is mainly because local SOEs and the private firm that were studied have long-term, insider top managers. Moreover, these two types of firms face intense competition in the domestic market. Therefore, top managers of local SOEs and private firms are highly motivated to adopt embedded BUL practices.

However, amongst the seven cases studied, local SOEs have access to capital, and the private firm does not. This scenario limits the capability of private firms to adopt expensive embedded BUL practices. Therefore, the private firm can only achieve a moderate level of BUL embeddedness.

Second, empirical findings in this research show that the level of BUL embeddedness, as discussed previously in this section, can be explained by different combinations of four institutional factors. More importantly, it is found that those four institutional factors must be used together to explain the level of BUL embeddedness of the seven cases in this study.

For example, good BUL embeddedness is found in local SOEs with an insider as the top manager, having long-term employment of the top manager, facing intense competition in the domestic market, and having access to high levels of capital.

However, because private firms have limited access to capital, they could not afford to adopt more embedded BUL practices even though they have motivated top managers.

Therefore, to fully explain the current level of BUL embeddedness, four institutional factors should be simultaneously considered. Failing to include any one of them would prevent a full explanation being developed for a firm's level of BUL embeddedness from a Chinese NSI perspective.

6.4 Research Contribution

This section discusses the contribution that this thesis makes to current theories and practices that will be discussed respectively in the following sub-sections. The thesis contributes to three fields of literature: Section 6.4.1 discusses its contribution to China's NSI studies. Section 6.4.2 discusses its contribution to studies on corporate governance and firms' innovation performance in China. Section 6.4.3 discusses its contribution to BUL literature. Section 6.4.4 discusses the conceptual framework that will be updated with the findings of this research.

This thesis also contributes to contemporary practices by providing new insights to management practitioners and policymakers. Section 2746.4.5 discusses the management implications of this research. Section 6.4.6 discusses the policy implication of this thesis.

6.4.1 Contribution to studies on China's NSI

To respond to the research objective – to develop an understanding of the impact of China's NSI on innovation activities in firms. This research studies three elements of China's NSI, namely 1) corporate governance system, 2) a firm's access to capital and 3) market competition. Corporate governance is further divided into two factors including 1) whether the top manager of a firm is an insider or an outsider, and 2) whether the length of employment of the top manager is short-term or long-term.

This research formulates a theoretical framework consisting of four institutional factors to analyse and evaluate the impact of China's corporate governance system, the firm's access to capital and market competition on firms' BUL.

This four-factor framework is developed by drawing on and synthesising from various literature (Tylecote and Cai, 2004; Cai and Tylecote, 2005; Liu and Tylecote, 2009; Tylecote, Cai and Liu, 2010; Peng *et al.*, 2005; Yiu and Lau, 2008).

The four factors include: 1) whether the top manager of a firm is an insider or outsider, 2) the length of the top manager's employment, 3) the firm's access to capital, and 4) the level of competition.

The first three factors are based on combining the F&CG model developed by Tylecote and his colleagues (e.g. Tylecote and Conesa, 1999; Miozzo and Tylecote, 2001; Tylecote *et al.*, 2002; Cai and Tylecote, 2005; Tylecote and Ramirez, 2006; Tylecote, 2007; Liu and Tylecote, 2016) with the network-based resource capital model created by Peng, Lee and Wang (2005) and Yiu and Lau (2008: 36).

During the data analysis, it was established that the research findings could not be fully explained by the first three factors. Further analysis found that the level of competition

faced by firms has a significant influence on the level of BUL embeddedness of firms. By adding the market competition factor, the research findings could then be fully explained.

Therefore, this research contributes to the existing literature by adding a market competition factor to the F&CG framework to explain the level of BUL embeddedness of firms. This four-factor framework contributes to studies on interaction between China's NSI and firms' innovation activities by explaining how CG, firms' access to capital and market competition influence firms' BUL.

Each of the four factors will be discussed in the following paragraphs by comparing current literature with empirical findings. It should be stressed that each factor individually is not sufficient to explain the level of embeddedness of BUL practice of firms. It requires a combination of four factors to explain the variances in the level of embeddedness of BUL practices within the seven cases being studied.

Insider vs. outsider top manager

As suggested by the literature, having an insider as the top manager improves a firm's innovation capability (Tylecote and Cai, 2004; Liu and Tylecote, 2009; O' Sullivan, 2000). This is because outsider top managers do not possess sufficient levels of firm-specific knowledge to observe low-visibility innovation activities that take place on the shop floor (Liu and Tylecote, 2009). Moreover, without such insider knowledge, outsiders are not likely to appreciate low visibility and slow-pay-off activities (ibid) like BUL. Therefore, the level of embeddedness of BUL practices would be lower when the top manager of a firm is an outsider.

Empirical findings in this research are in line with the literature showing that firms with insiders as top managers have, in general, a higher level of BUL embeddedness than firms with outsiders as top managers.

This factor is proved to be an effective indicator that demonstrates whether the top manager of a firm has sufficient levels of knowledge to observe and appreciate low visibility and slow-pay-off BUL activities (Wei *et al.*, 2011). If the top manager is an insider who has rich, firm-specific knowledge, developed over years of working in the firm, they will be able to observe and appreciate BUL effects amongst shop floor employees.

However, this factor alone is not a sufficient indicator of the level of embeddedness of BUL practices of firms. It is because empirical evidence shows that some firms with outsiders as top managers have a moderate level of embedded BUL practice. This research shows that an outsider top manager can still implement these practices if they have the incentive to do so. For example, when the firm faces competition in the domestic market.

This finding shows that, whether the top manager of a firm is an insider or an outsider is not a decisive factor on its own in determining the level of BUL embeddedness in the firm. Therefore, other factors need to be taken into consideration to explain the level of BUL embeddedness of those firms studied.

Length of employment of top manager

As suggested in the literature, the length of employment of the top manager has a significant impact on their decision-making in terms of planning for long or short-term developments of innovation capability (Tylecote and Cai, 2004; Tylecote *et al.*, 2010). It

also has a significant impact on the level of the top manager's incentive to adopt slow-pay-off activities like BUL. Under short-term employment, top managers are more inclined to adopt short-term practices to improve the firm's innovation capability and to boost its profitability, such as by adopting technological bundles (Cai and Tylecote, 2005). This is because they want to please their superiors to place them at a higher position after 4-5 years. This kind of short-term behaviour, in the long run, neglects the importance of developing an internal innovation capability (ibid).

Empirical findings from this research are in line with the existing literature showing that firms with long-term employment of top managers have a higher level of embeddedness of BUL practices, in general, than firms with short-term employment of top managers. This finding suggests that the length of employment of the top manager is an effective factor that indicates whether or not top managers of firms have the motivation to adopt an embedded BUL practice.

However, as already mentioned above, this factor alone does not explain why some firms with only short-term employment of top managers still have a moderate level of embeddedness of BUL practices. Therefore, more factors need to be taken into consideration to understand this phenomenon.

Access to capital

Much literature on the subject of China's NSI and China's SOEs argue that China's SOEs have privileged access to scarce capital in comparison to private firms (e.g. Cai and Tylecote, 2005; Liu and White, 2001; Xue *et al.*, 2011; Okazaki, 2017). Poor access to capital would consequently limit the capability of the firm to develop a high BUL

embeddedness because embedded BUL practices require a high level of financial investment.

This research confirms the argument of previous literature that SOEs have access to much more capital than the private firm. The private firm has only moderate BUL embeddedness because they cannot afford to have many embedded BUL practices. Therefore, a lack of access to capital will limit the firm's capability to adopt embedded BUL practices.

Although the literature suggests that BUL is a cost-less approach to develop innovation capability and innovation performance of firms (Bessant *et al.*, 1994), this research shows that it is, in fact, very expensive to adopt highly embedded BUL practices.

Based on the experiences cited by Cases B and C (Local SOEs, Auto), highly embedded BUL practices require a high level of investment in, for example, proposal systems supported by advanced IT systems and heavy financial rewards, problem-solving mechanisms at the expense of labour hours and experiments, internal training systems supported by expenditure on developing internal trainees. All of these highly embedded BUL practices require a high level of capital which is not, in general, accessible to private firms in China.

However, a firm's access to capital is not a deciding factor when determining the level of BUL embeddedness of firms. This research found that having high access to capital does not necessarily lead to a high level of BUL embeddedness, because central SOEs that were studied, and that have good access to capital, only have poor or moderate BUL embeddedness. This is because central SOEs have little or no competition in the domestic market in general.

Therefore, the competition factor is added to the three CG&F factors to fully explain the level of BUL embeddedness in firms.

Market competition

The crucial role played by market competition in forcing firms to actively engage in innovation activities has been recognised by some highly regarded innovation scholars like Rosenberg (1992) and Freeman (1995).

Competition is an important factor that influences the innovation activities of firms. In an historical work studying planned economy in Union of Soviet Socialist Republics (USSR), Rosenberg (1992) argues that the lack of competition in the planned economy allows firms to survive without developing any innovation because they do not face threats from rivals in the domestic market. In addition, innovation has inherent elements of risks which deters managers from innovation activities when their survival does not rely on them. In contrast, competition in a capitalist economy forces firms to actively engage with innovation to gain a competitive advantage. Although innovation involves risk, not innovating in a competitive market could be fatal (Rosenberg, 1992).

Freeman (1995) identifies low levels of competition as one of the main reasons why the USSR had such low levels of innovation capability in comparison to Japan in the 1980s.

This research finds that market competition leads to improved BUL embeddedness and innovation capability because firms must innovate in order to address threats from their rivals. Therefore, due to the high cost of failure in innovation, firms would avoid it if they could. However, when they face competition, they cannot avoid innovation.

This factor is specifically important in the context of Chinese firms, depending on the sectors that are open to competition and to some extent where decisions are political. The

survival of SOEs in China is principally due to the control of market competition in certain sectors (Liu and Tylecote, 2016). If firms enjoy monopolistic status in their field and are protected by government plans, they do not have to innovate, just like in the case of the USSR (Rosenberg, 1992; Freeman, 1995).

However, in line with other factors, the level of embeddedness of BUL practices of firms could not be fully explained merely by whether or not the company faces market competition. For example, the private firm operating in a highly fragmented market producing parts for fuel supplying system for engines. It has moderate BUL embeddedness due to its lack of access to capital. Therefore, more factors need to be considered to understand this phenomenon.

From previous discussions on how the four institutional factors explain the level of BUL embeddedness of firms, it is evident that each factor alone is not sufficient to explain the level of BUL embeddedness in firms. It requires a combination of the four factors to develop a full explanation of the variances in the level of embeddedness of BUL practices amongst the seven cases in question.

6.4.2 Contributions to the literature on corporate governance and firm innovation performance

This thesis contributes to studies on innovation of China's SOEs in general by distinguishing local SOEs from central SOEs in how they are managed by the government at different levels. Existing literature on China's NSI, China's SOEs, and China's economic reforms tend to group SOEs owned by the government at different levels (i.e. central, provincial and city) into one group which suggests that SOEs, owned by a

different level of government, have similar styles of innovation activities (e.g. Liu and White, 2001; Liu and Lundin, 2007; Liu, 2009; Xiao *et al.*, 2013).

However, empirical evidence from this research shows that central SOEs and local SOEs are managed differently by the government at different levels in two aspects.

First, empirical evidence shows that the local government has a tendency to appoint an insider as the top manager of local SOEs. However, central government tends to appoint outsiders to the central SOEs.

Second, the top manager in local SOEs could remain in that position for a long period of time so that they have time to develop firm-specific knowledge, which is beneficial to BUL. However, the top managers in central SOEs only stay in that position for about 3-4 years before they are transferred to ministry offices or to other central SOEs as suggested by Tylecote *et al.* (2010).

A recent study, using the panel data of listed firms in China, Kou and Henning (2017), argues that SOEs owned by provincial and city level governments have a better innovation performance than those SOEs owned by the central government. Findings in this research are in line with this, showing that central SOEs are less engaged with innovation activities than are local SOEs. It is because central SOEs have outsider top managers with short-term employment. Top managers of central SOEs tend to avoid innovation as they do not face competition in the domestic market.

Distinguishing central SOEs from local SOEs has important implications for innovation studies on China's SOEs because it shows that SOEs could be very innovative if they are managed in the appropriate way, i.e. by appointing an insider as their top manager coupled with long term employment.

6.4.3 Contribution to BUL literature

This research contributes to BUL literature by initiating efforts to operationalise the concept of BUL to make it a practical management tool for developing an innovation capability in firms.

Although the concept of BUL has been widely suggested as an important approach to develop innovation capability (March, 1991; Bessant and Caffyn, 1997; Lam, 2002; Mom *et al.*, 2006; Andersen, 2008; Aoki, 2008; Høyrup, 2010; Wei *et al.*, 2011), the breadth of literature that focusses on how BUL is implemented in firms, and how to evaluate the embeddedness of BUL practices, is considerably limited. Therefore, this research has initiated efforts to operationalise the concept of BUL to make it a useful tool or approach to develop an innovation capability in firms.

Five major types of BUL practices have been identified in the seven featured cases, namely:

- Proposal systems
- Problem-solving mechanisms
- Work-related record keeping
- Internal training
- Job rotation

Additionally, the criteria of embedded BUL practices has been established based on the literature and has subsequently been proven to be effective by the empirical findings.

In the following discussions, the criteria for embedded BUL practices will be summarised in order to propose a practical list of BUL practices, as well as how to improve the level of embeddedness of BUL practices. (also summarised in Table 6-1)

An embedded proposal system requires a high level of support from top managers. This is because implementation of any new suggestions requires cooperation and resource allocation across functional departments. Managers at lower levels simply do not have enough authority to make such decisions. Moreover, data collection events need to be run frequently to develop a climate for employees to actively propose suggestions. Furthermore, embedded proposal systems should include all employees so that everyone has an opportunity to share their knowledge in their specialised fields. Lastly, rewards for high quality suggestions should be attractive enough to motivate employees.

Embedded problem-solving mechanisms should mainly be based on multi-disciplinary teams. Such team-based, problem-solving mechanisms not only allow problems to be tackled from different angles, but also allows team members to learn from experts in different disciplines. Moreover, the problem-solving process should be organised based on certain problem-solving approaches such as 8D or PDCA. This is because systematic problem-solving processes enable knowledge creation and effective learning (Tjosvold *et al.*, 2004).

Embedded work-related record keeping systems should be highly integrated with a firm's Office Automation (OA) system. This helps employees to record problems they are encountering at work in multiple formats, such as making use of photography and videos. Moreover, OA systems allow managers at different levels to conveniently review work records. Frequent management reviews of work records are another important indication

of any embedded work record keeping systems. The management of a firm should invest time and effort to identify problems and also good practice on the shop floor.

Table 6-5: Summary of criteria for embedded BUL practices

BUL Practices	Embedded	Not embedded
Proposal system	Top management support	Limited management support
	Frequent (at least every six months)	Infrequently (once a year or less)
	All employees	Limited employees
	Heavily rewarded	Poorly rewarded
Problem-solving mechanism	Team-based	Individual-based
	Defined and structured	Undefined and unstructured
Detailed work record keeping	Highly integrated with Office Automation software	Paper based, not integrated to office system
	Regularly reviewed by managers	Not or rarely reviewed by managers
Internal training	Including all employees or including production workers	Limited to manager or senior engineers.
	Have formal internal training development programmes	Not have formal internal training development programmes
	Frequently or regularly	Occasionally
Job rotation	Structured and planed	Unstructured and unplanned
	Including junior employees	Only limited to managers

Embedded internal training programmes should involve shop floor workers instead of limiting their availability to only managers and senior level engineers. This is because shop floor workers have a large amount of tacit knowledge developed from repeatedly performing their role. Their experiences and insight could be shared with their fellow workers if given a platform to deliver lectures in their field of expertise. Moreover, embedded internal training programmes should be underpinned by well-established internal training development programmes, specifically because employees are not trained teachers, they need professional help with developing their teaching skills and

other skills to prepare teaching materials, this is a process for transforming their tacit knowledge into explicit knowledge.

Embedded job rotation should be well planned so that workers are given the opportunity to develop knowledge of different functional departments. Moreover, job rotation programmes should primarily focus on new or young employees because they have the highest potential for developing firm-specific knowledge.

An interesting finding of this research is that embedded BUL practices often require a high level of investment in introducing a new OA system, hiring professional consultancy companies to design new management structures, heavy investment in financial rewards to employees, costs associated with providing internal training to employees, and so on.

This finding contradicts the previous literature that has suggested that by using employees' knowledge to make improvements and innovation is a cost-less approach to improving innovation performance (Bessant *et al.*, 1994). This research proposes that BUL activities might seem to be free but costs associated with adopting and running BUL practices are very high based on those empirical findings.

6.4.4 The updated conceptual framework

Based on research findings, a new conceptual framework is proposed. (see Illustration 6-1 and Illustration 6-2).

In the new conceptual framework, links 1a, 1b and 2a remain the same.

Illustration 6-1: Conceptual framework based on literature

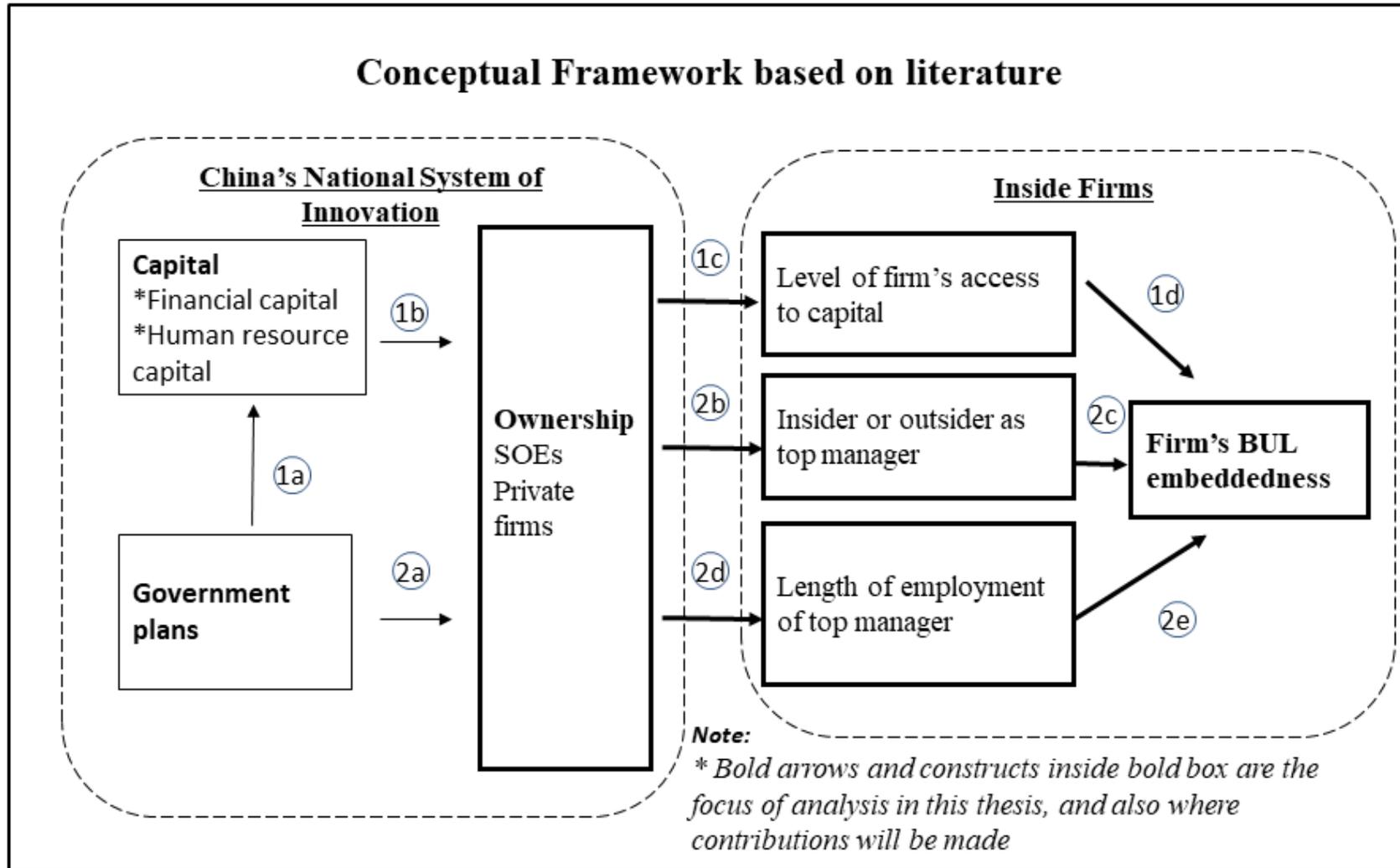
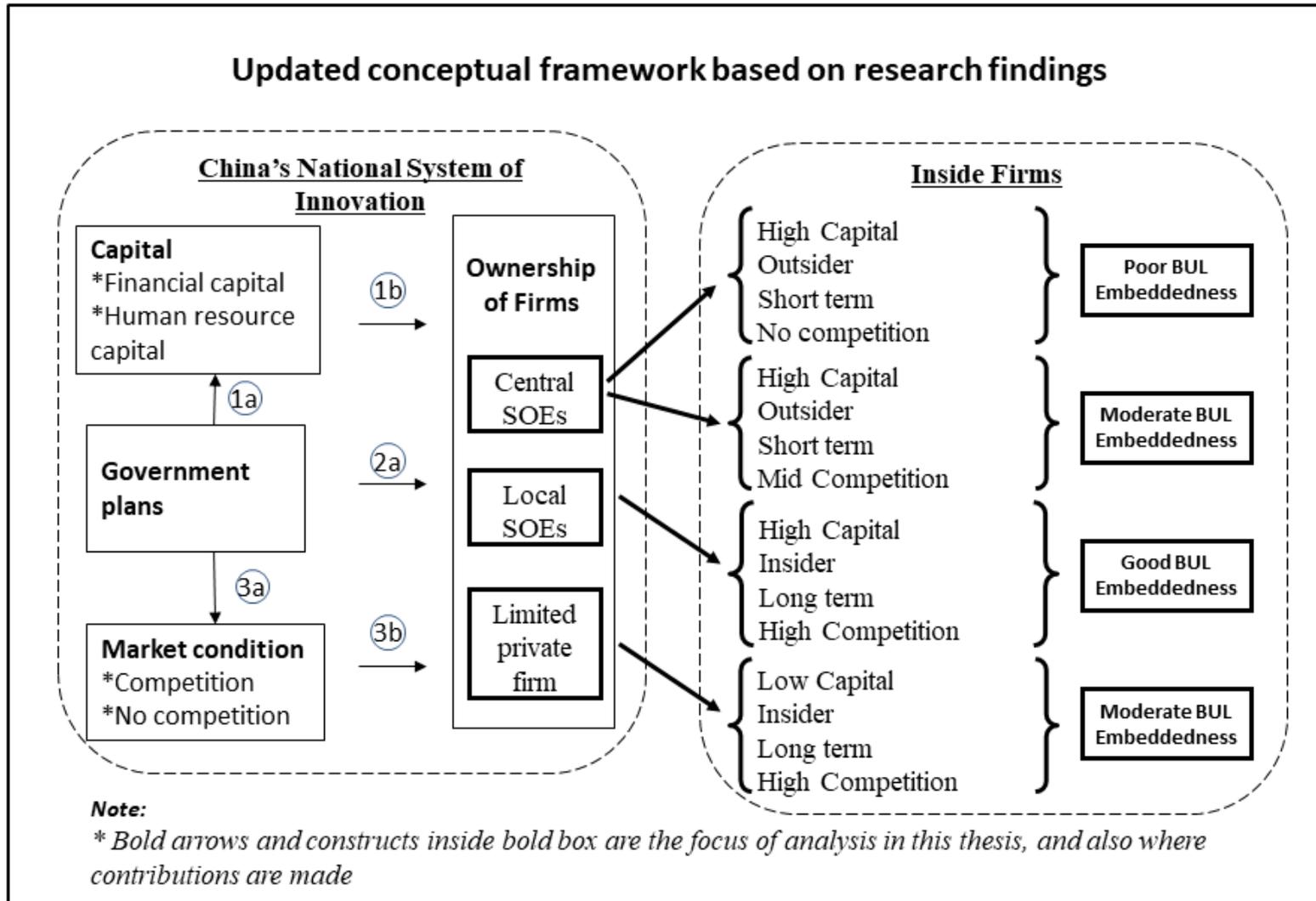


Illustration 6-2: Updated conceptual framework based on findings



Links 1a and 1b denote the impact of government plans on what capital is provided to firms with different ownership, namely central SOEs, local SOEs and private firms. SOEs and private firms will receive both financial and human resource capital from the government, but to different levels.

Link 2a denotes that government plans influence the corporate governance of SOEs by appointing top managers directly by SASAC.

A new market competition factor has been added as an institutional factor within China's NSI that influences a firm's BUL embeddedness.

Links 3a and 3b denote that government plans determine the level of competition that a firm faces because governments make political decisions on what sectors are open to competition and to what extent.

On the right-hand side of the conceptual framework, the original three institutional factors have been expanded to four factors by adding in the level of market competition. Moreover, the findings in this research are displayed in the new framework by linking four combinations of factors with the level of BUL embeddedness found amongst the cases in point

6.4.5 Managerial implications

This research provides new insight into management practices in two areas.

Firstly, earlier literature often argues that outsider top managers lack firm-specific knowledge because they are disengaged with their firm. However, this research shows that outsiders can develop sufficient firm-specific knowledge in a short period of time if they actively engage in the firm's operations and are willing to plan for the long-term

development of the firm. Thus, they would be able to observe and appreciate low-visibility and slow-pay-off BUL activities.

Although empirical evidence shows that the top managers of central SOEs are only appointed for a short period of time, long terms plans might be preferable by those top managers if the incentive mechanisms are right. For example, governments could encourage top managers of central SOEs to make long term plans in areas like developing a long-term innovation capability through adopting embedded BUL practices. In addition, the supervisory agency could develop a new performance evaluation system that takes long term development of SOEs into consideration. In this way, new top managers will have the incentive to follow up on plans made by their predecessors.

Secondly, for private firms that often have limited access to capital, they could also adopt embedded BUL practices. For example, Case D (Private, Auto) who cannot afford to buy professional and customised OA software for managing work records has chosen a cheaper route, that is to develop a system in a DIY fashion internally, using a generic software like Microsoft Office. Therefore, private firms could still develop an innovative capability through BUL in the long run if they can design and develop some embedded BUL practices internally even though they have limited access to capital.

6.4.6 Policy implications

Based on the empirical findings in this research, this research proposes a few new insights to policymakers to help them develop the innovation capability of SOEs and private firms using BUL as a learning approach for innovation.

Firstly, policy makers should introduce competition in sectors controlled by monopolistic central SOEs. As suggested from the empirical findings, some central SOEs have

moderate BUL embeddedness because they face some degree of competition in the domestic market.

Secondly, the government should primarily appoint insiders as the top managers of their SOEs, and the term of employment of top managers should be long enough to encourage those top managers to make long term plans for developing an innovative capability. Although the long-term appointment of a top manager in SOEs might lead to problems like corruption (Ge *et al.*, 2014), other measures could be adopted to deal with such issues. However, disengaged outsider top managers having short-term employment impede firms' BUL. Therefore, appointing an insider for long term employment could be an effective way to improve BUL embeddedness of SOEs, which will consequently lead to improved innovation and economic performance of SOEs. Alternatively, policies that promote engagement and long-term planning of top managers in SOEs are essential.

Thirdly, policy makers should help private firms to gain access to capital because the lack of capital considerably constrains their capability to develop innovative capabilities. It has been reported for decades that private firms face limited access to capital in comparison to SOEs (e.g. Cai and Tylecote, 2005; Liu and White, 2001; Tylecote *et al.*, 2010). Regardless of this, several rounds of reforms in China's banking and finance sectors, empirical findings show this situation has still not been significantly improved (Xue *et al.*, 2011; Okazaki, 2017).

Private firms normally have highly engaged top managers and incentives to plan for long term development. Moreover, private firms in China face intense market competition so that they have to innovate to protect their market share. Based on the four-factor framework proposed in this thesis, lacking access to capital is the only factor that prevents

the private firm from adopting all five embedded BUL practices. It is reasonable to predict that if private firms have access to a high level of capital like SOEs, their BUL embeddedness will be as high as local SOEs.

6.5 Research Limitations and Further Research Recommendations

Although this research has successfully addressed three research questions and has fulfilled the research objective – to understand the impact of China’s NSI on BUL embeddedness in firms. This research has several limitations in its theories, research design, and generalisability of results. Therefore, several recommendations for future research are proposed below.

- 1) This research aims to understand the impact of China’s NSI on firms’ BUL embeddedness. However, only four institutional factors have been chosen when trying to explain the level of BUL embeddedness of cases studied. Although the four-factor framework has been empirically proved useful in providing explanations to current BUL embeddedness of the seven cases, China’s NSI may include more factors that could provide other angles to analyse cases, like the national education system of workers, the stock market as a source of capital for firms, industrial plans in certain sectors, and so on. Every one of those institutional factors could influence the BUL embeddedness of Chinese firms even though such links have not been found in any mainstream literature yet. Therefore, extra institutional factors are expected to be added to the four-factor framework to provide more comprehensive explanations as to how China’s NSI influences BUL embeddedness of firms in China.

Organisational studies literature could also help with providing more factors that could influence the embeddedness of BUL practices. For example, the size of the

firms would be an important factor as this will significantly influence the hierarchy and structure of the management. Two cases in this research are small central SOEs who have more embedded BUL than other large, central SOEs studied. This suggests that being a small sized firm could make adopting embedded BUL practices more easily if the firm have the initiative to adopt BUL that is triggered by market competition. Thus, the firm's size should be taken into consideration in future researches on BUL.

- 2) Only five types of BUL practices have been studied in this research. In the literature review chapter, five other BUL practices have been identified but they have been excluded during the data analysis because none of the seven cases in point have adopted them. Nevertheless, it is possible to find those excluded BUL practices in other research contexts if more cases have been studied. Unfortunately, due to constraints on time and resources in this PhD project, it is beyond the capability of the author to include more cases. Therefore, more cases and more BUL practices are expected to be studied in future research.
- 3) This research has only studied two engineering sectors, which are commercial vehicles and railway equipment. As suggested in earlier literature (Dosi, 1988a; Lundvall, 1992; Freeman, 1994; Tidd *et al.*, 2005; Lundvall, 2010), the foundation of innovation is interactive learning and creative problem solving. Thus, BUL could certainly play a critical role in other sectors, particularly in other engineering sectors that rely on a similar knowledge base to the seven firms studied. This is because BUL is a learning approach that facilitates interactive learning across the entire workforce, and encourages creative problem solving.

Future research could further study the role of BUL in developing firms' innovation capability in other engineering sectors.

- 4) This research uses cross-sectional data to compare the combination of the four institutional factors faced by each case and to compare their BUL embeddedness. However, it should be noted that those firms might be at different stages of implementing embedded BUL practices. Firms that recently started to adopt BUL practices might show low BUL embeddedness as they have little experience in managing those practices. In addition, the effect of BUL may not be visible in the short term because BUL is a slow-pay-off learning approach aiming to develop innovation capability in firms in the long run. Moreover, based on case data, BUL practices tend to evolve after years of implementation. Therefore, if time and resources are available, it would be useful to conduct longitudinal studies to comprehensively explore how BUL practices evolve over time, and how BUL helps firms to gradually develop innovation capability.
- 5) This research is primarily based on qualitative data from in-depth semi-structured interviews with mainly high and middle level managers. Because this research aims to explore how firms adopt BUL practices, those managers were deemed as appropriate respondents. However, these managers were unable provide information on the opinions of shop floor employees. The information on how employees react to BUL practices is missing. Therefore, future research could focus specifically on studying how operating staff participate in BUL practices and how this learning approach helps them improve their knowledge and skill sets.
- 6) This research only studied seven Chinese firms including four central SOEs, two local SEOs and one private firm. 37 interviews have been conducted in total.

Although such a sample size is sufficient for a PhD research project, it is still beyond the capability of this research to produce more generalised results. Therefore, if time and resources allow, industry-wide surveys could be conducted in future quantitative research using questionnaires developed and based on the updated conceptual framework (see Section 6.4.4) and the list of criteria for embedded BUL practices (see Section 6.4.3). This could produce more convincing and rigorous results that can be generalised.

- 7) Firms studied have been broadly classified into three groups including, central SOEs, local SOEs, and private firms. This classification hides any differences in the ownership structure within each group. Within the central SOEs group, Cases A and E are fully owned by the government, but Case F has around 35% of its shares owned by private firms, and Case G is a 50:50 joint venture between a fully central SOE and a foreign, private firm in France. Within the local SOEs group, Case B has multiple shareholders including both SOEs and private firms, and part of it has been listed on various stock markets. Case C is collectively owned by two large, local SOEs in two provinces of China respectively. The private firm, Case D, is owned by all the employees of that firm, where the managers have their own shares but workers only have shares that are collectively controlled by an Employee Shareholding Committee. According to the work by Cai and Tylecote (2005), the percentage of state ownership in SOEs has an impact on the firms' innovation performance. This suggests that the detailed difference in ownership amongst seven cases studied could have an impact on their BUL embeddedness. Thus, the detailed structure of firms' ownership should be included in future studies to see whether this influences firms' adoption of BUL practices.

- 8) This research primarily studies the powerful role that the Chinese government plays by intervening in the market when establishing a large number of SOEs in important sectors. The lesson learned from this research could also provide some insight on understanding the role of the state in other countries where the state also plays a significant role in controlling the market either through, or not through, establishing SOEs. As shown in this research and backed by some existing innovation studies, the institutional environment built by national systems of innovation will have an impact on firms' innovation activities (Freeman, 1994; Nelson, 1991; Fuller, 2016). Therefore, the four-factor model developed in this research could be applied to other countries where the state has a strong presence in the market.
- 9) The lesson from this research could also be transferred to other countries where SOEs are present. The management of SOEs by the state is not necessarily the same across other countries. It would be valuable to apply the four-factor model to study how NSI impact SOEs in other countries where the state manages and controls SOEs in similar ways to China.
- 10) When studying BUL in a national setting in future research, culture could also be an influential factor that has an impact on the implementation of BUL practices. As discussed earlier in Chapter 2 Section 2.3.1.5 on page 49, Japan has a suitable cultural environment at societal and individual level that encourages employees to propose suggestions and make change to existing work. Whilst China's collectivist culture is, to some degree, in conflict with the notion of BUL, which requires proposing potentially critical suggestions to co-workers and their superiors, as well as changing existing work. Thus, it is reasonable to propose that

the culture of a country could facilitate or hinder BUL for innovation, which make it easier, or more difficult, for firms in some countries to have embedded BUL.

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APPENDICES

Appendix A: Informed Consent Form



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Informed Consent Form 《同意书》

Name of Researcher 研究人员姓名
Zhongzhen Miao 苗仲桢
Title of study 课题名称
Bottom-up learning for innovation in firms in China 《中国企业员工以创新为目标自下而上的学习行为》
Governing Body and Supervisors 管理机构和导师姓名
Dr. Paulina Ramirez & Dr. Yufeng Zhang at the University of Birmingham 英国伯明翰大学, Paulina Ramirez 博士 和 张玉峰 博士

The main purpose of this form is to provide information that may affect your decision about whether or not you want to participate in this research project. If you choose to participate, please sign in the space at the end of this form to record your consent.

这份《同意书》的作用是介绍本研究的内容，并由您决定是否参与本研究项目。如果您决定参与本研究项目，请在《同意书》末页签字。

WHO IS DOING THE RESEARCH? 研究人员信息

Zhongzhen Miao, a doctoral researcher under the direction of Dr. Paulina Ramirez and Dr. Yufeng Zhang in the Birmingham Business School at the University of Birmingham, is conducting a research study, titled Bottom-up learning for innovation in state owned enterprises in China, to study how different degree of acceptances to bottom-up learning behavior could influence company's technical innovation capability and innovation performances, and is inviting you to participate in it.

苗仲桢，英国伯明翰大学商学院博士生。导师为 Paulina Ramirez 博士和张玉峰博士。研究课

题为《中国国有企业员工以创新为目标自下而上的学习行为》。本课题旨在分析，企业对员工自主式学习行为的接受和鼓励与否，如何影响企业技术创新能力的发展。热诚邀请您参与本课题研究。

WHAT DOES PARTICIPATION IN THIS RESEARCH STUDY INVOLVE? 参与研究的过程

If you decide to participate in this study, you will be interviewed at a place of your choice. Your participation will take approximately one hour. If approved by you, you will be audio taped during your participation in this research. Audio recordings will be confidential. These audio recordings would significantly increase the accuracy of data and reduce work load of data analysis stage later on.

在您决定参与研究之后，我会和您约定地点和时间，对您进行大约 1 个小时的采访。在经过您允许的情况下，我会对采访进行录音。录音内容会被保密。录音资料可以极大地提高数据的准确度，并减少后期数据分析的工作量。

WHY ARE YOU BEING ASKED TO PARTICIPATE? 被采访者选择标准

You have been invited to participate because you are an experienced senior level manager working in a firm in automobile sector or railway equipment sector in China.

您被邀请参与本课题研究是因为您是一位有丰富经验的中国汽车或铁路设备企业的高层管理人员。

ARE THERE ANY BENEFITS TO PARTICIPATION? 参与课题的益处

- a) When your participation is complete, you will be given an opportunity to learn about this research, which may be useful to you in your career of managing innovative workforces.
- b) You will have new insights in understanding how to make/adjust innovation strategies to increase innovation performance.

- a) 在课题结束后，您可以详细了解研究的内容以及结果。希望研究结果可以为您在未来工作中提供有价值的参考。
- b) 您可以在研究过程中可以了解如何制定和调整创新战略，以期提高企业的创新能力。

ARE THERE ANY RISKS INVOLVED IN THIS STUDY? 参与本课题的风险

We don't anticipate any risks to you from participation in this study.

在此课题研究中，您不承担任何可预知的风险。

WHAT HAPPENS IF THE RESEARCHER GETS NEW INFORMATION DURING THE STUDY?

课题发生变化

The researcher will contact you if he learns new information that could change your decision about participating in this study.

如果课题内容发生变化，我将联系您。您可以决定是否继续参与本课题。

HOW WILL THE RESEARCHER PROTECT MY CONFIDENTIALITY? 对研究数据和参与者的保护

The results of the research study will be submitted to the University of Birmingham, and may be published later on, but your name or identity will not be revealed. In order to maintain confidentiality of your records, the researcher will use codes to replace yours and your company's name.

All data collected from you will be stored encrypted and used solely for research purposes. Upon completion of study, data will be kept for ten years.

研究结果将被用来完成伯明翰大学博士学位论文，并有可能用于学术论文发表。但是，在未经您授权的情况下，文中您和您公司的名字将会由编号代替，以保护您的隐私。

所有数据将会加密保存，并仅用于学术研究。在项目完成后，所有数据将会被封存 10 年。

WHAT HAPPENS IF I DON'T WANT TO CONTINUE IN THE STUDY? 如何退出课题研究

If you choose to withdraw from the study, the deadline is 01/01/2016. There will be no further consequences for you to withdraw from the study. Your data will be destroyed.

Please contact Zhongzhen Miao via [REDACTED]

如果您决定退出本课题项目，请您在 2016 年 1 月 1 日前联系我。退出本课题研究您不会承担任何后果。您所提供的数据将会被销毁。我的邮箱 [REDACTED]

VOLUNTARY CONSENT 自愿声明

By signing this form, you are saying:

- (a) that you have read this form or have had it read to you and
- (b) that you understand this form, the research study, and its risks and benefits.

签署这份《同意书》代表您声明：

- (a) 您已阅读过这份《同意书》或有人将这份《同意书》朗读给您听；
- (b) 您充分理解明白本《同意书》的内容，本课题研究的目的是，和参与本课题研究的利益和风险。

The researcher will be happy to answer any questions you have about the research. If you have any questions, please feel free to contact Zhongzhen Miao at [REDACTED] .

如果您有疑问，研究人员将乐意为您解答。请通过邮件 [REDACTED] 联系苗仲桢。

Note: By signing below, you are telling the researchers “Yes,” you participate in this study. Please keep one copy of this form for your records.

请注意，在下方签名代表您同意参加上述课题研究项目。请您妥善保存本《同意书》的副本。

Your Signature 签名: _____

Your Name (please print) 姓名（拼音）: _____

Date 日期: _____

INVESTIGATOR'S STATEMENT 研究员承诺

I certify that this form includes all information concerning the study relevant to the protection of the rights of the participants, including the nature and purpose of this research, benefits, risks, confidentiality and right of withdrawing. I have described the rights and protections afforded to research participants and have done nothing to pressure, coerce, or falsely entice this person to participate. I am available to answer the participant's questions and have encouraged him or her to ask additional questions at any time during the course of the study.

我承诺本《同意书》包含所有关于本课题研究需要告知参与者的信息，以保护参与者的权利。信息包括本次研究的内容和目的、参与的利益和风险、保密措施和退出研究的权利。我向参与者说明了相关权利，并描述了对他/她的保护措施。我保证没有压迫，强迫和误导参与者使

他们同意参与研究。

Investigator's Signature 研究员签名: _____

Investigator's Name 研究员姓名: Zhongzhen Miao 苗仲桢.

Date 日期: _____

Appendix B: Interview Guidance

Interview Guidance

1 Technological innovation of company

- 1.1 Numbers of new products, product improvement
- 1.2 Number of improvement in production process
- 1.3 Total number of R&D personnel
- 1.4 R&D investment

2 What is the process of a successful innovation project? (i.e. your star product or series of products)

- 2.1 What is considered as innovation in your company?
- 2.2 What are your company's advantages when conducting R&D or problem solving that could create new knowledge or innovation?
- 2.3 What kind of edge do these advantages give your company? What roles are they played in the innovation process in your company?
- 2.4 How do your company develop and manage these advantages?
- 2.5 What kind of challenges common to the innovating process of your company?
How do your company cope with those challenges?

3 Bottom-up learning activities.

- 3.1 What is the source of knowledge and technology commons to the company's innovation?
- 3.2 Does your company consider knowledge created during daily operations by shop floor employee/workers as a valuable source of knowledge for process and product innovation?

- 3.3 What is the main problem-solving method used by the company to solve technical problems?
- 3.4 Do your company setup teams specialised in solving problems arose from daily operations? Does your company organise multidiscipline teams?
- 3.5 What kind of decisions could those teams make? (Level of autonomy)
- 3.6 During formal R&D and daily problems solving events, do employees keep a detailed logbook to record what had happened and their thoughts about it, as well as proposed solutions?
- 3.7 Do workers keep production logbooks to record problems encountered at work?
- 3.8 How does your company make use of those kinds of logbooks for future innovation? Do managers frequently review them?
- 3.9 How your company allows employees propose their suggestions on making changes to existing product and production process? How are those suggestions handled and processed?
- 3.10 How your company encourages employees to help others when somebody has a new idea want to pursue?
- 3.11 How could active employees find the appropriate person for help? What is the mechanism for this? How does it work?
- 3.12 Does your company have job rotation to enrich employee breath of knowledge?
- 3.13 How your company allows employees learn from each other (i.e. writing documents or face to face communication)?
- 3.14 What is the level of employee engagement in daily work, in solving problems and in making suggestions?

- 3.15 Does your company have schemes to develop employees' technical innovative capability? Which part of employees is involved?
- 3.16 Does your company have a rewarding system for employees who make suggestions, help colleagues and share experiences?
- 3.17 How do your company recognise those active employees? What kind of role played by mid-level managers in this?
- 3.18 How do you company reward innovation?
- 3.19 Does high-level management frequently interact with shop floor employees to listen and understand employee's ideas to carry out the experimental project by themselves?
- 3.20 How managers support employees when they have suggestions and want to carry our experiments?

4 Corporate governance of company

- 4.1 Distributions of shares of your company
- 4.2 How and why this shareholding structure provides advantages and disadvantage to the company? (Including certain firm-specific policies, access to resources, etc.)
- 4.3 Do you receive supports from government? in what forms?
- 4.4 How and why central planning influences the decision-making process of company's management?
- 4.5 Is the top manager of your company appointed internally?
- 4.6 Does he/she have professional knowledge about the sector, about your company?
- 4.7 How long would the top manger work in your firm?

4.8 Do you agree with that “management structure in SOEs is too rigid to be responsive to new ideas and changes”? (I heard this idea at a conference of Chinese Engine manufacturers)

END OF INTERVIEW. THANK YOU.

Appendix C: Summary of Case and Interviewee Profiles

Summary of case profile

Company code	Sector	Industry	Ownership	Tier of SOEs (SASAC count as 0)	Degree of state shareholding
A	Automobile	Engine production	Central	3	Full
B	Automobile	Commercial vehicle production	Local	3	Majority
C	Automobile	Commercial vehicle production	Local	2	Full
D	Automobile	Engine fuel supplying system production	Private	N/A	None
E	Railway equipment	Locomotive production	Central	2	Full
F	Railway equipment	Pantograph production	Central	3	Majority
G	Railway equipment	Train coupler production	Central	3	50/50 JV

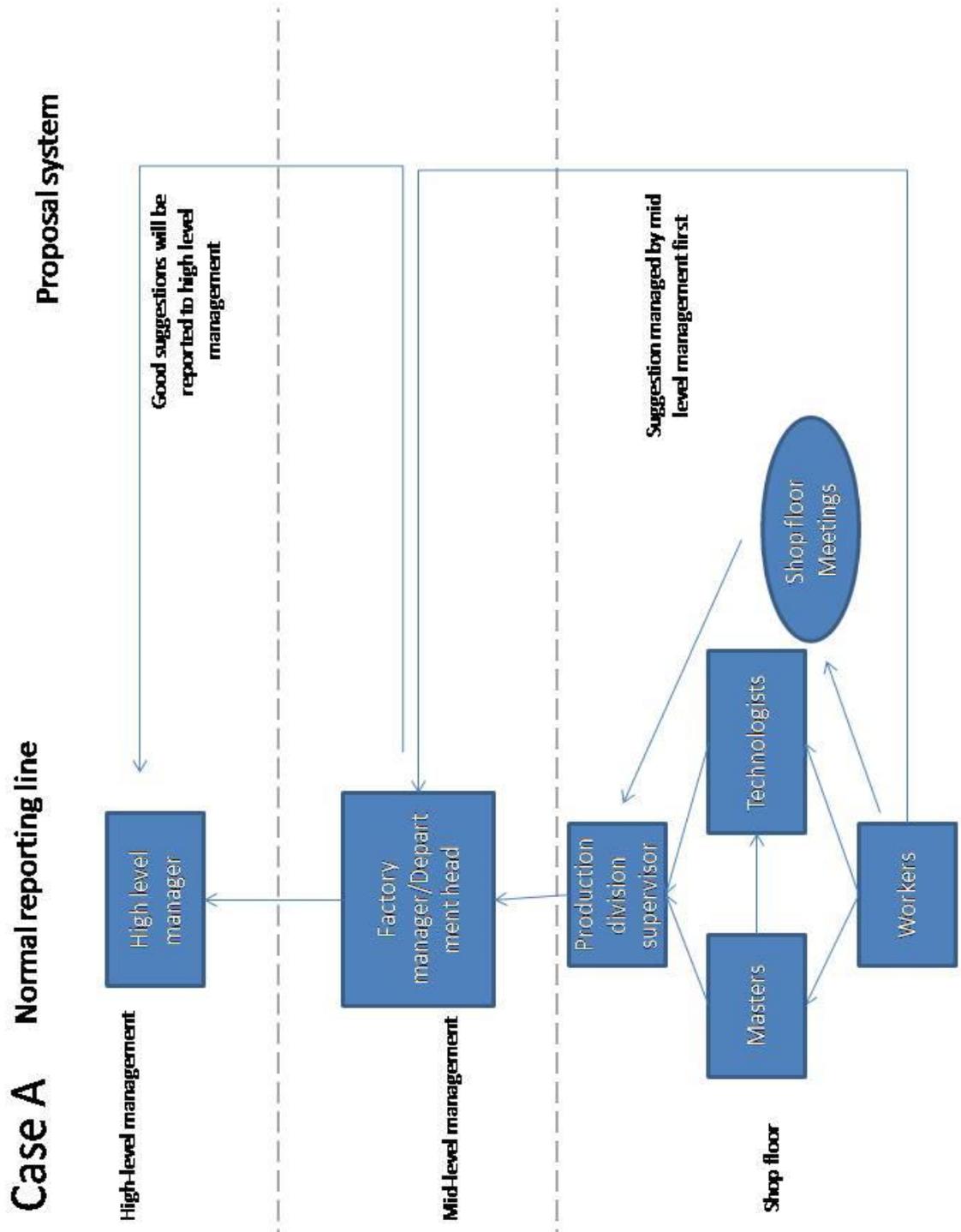
Summary of interviewee profiles

Interview number	Company	Level of interviewees	Position	Interviewee code cited in text	Note
1	A	High	Member of board of shareholder	A-BM	
2			Vice president	A-VP	
3			Chief engineer	A-CE	
4		Mid	Head of New product development Depart.	A-HoNPD	

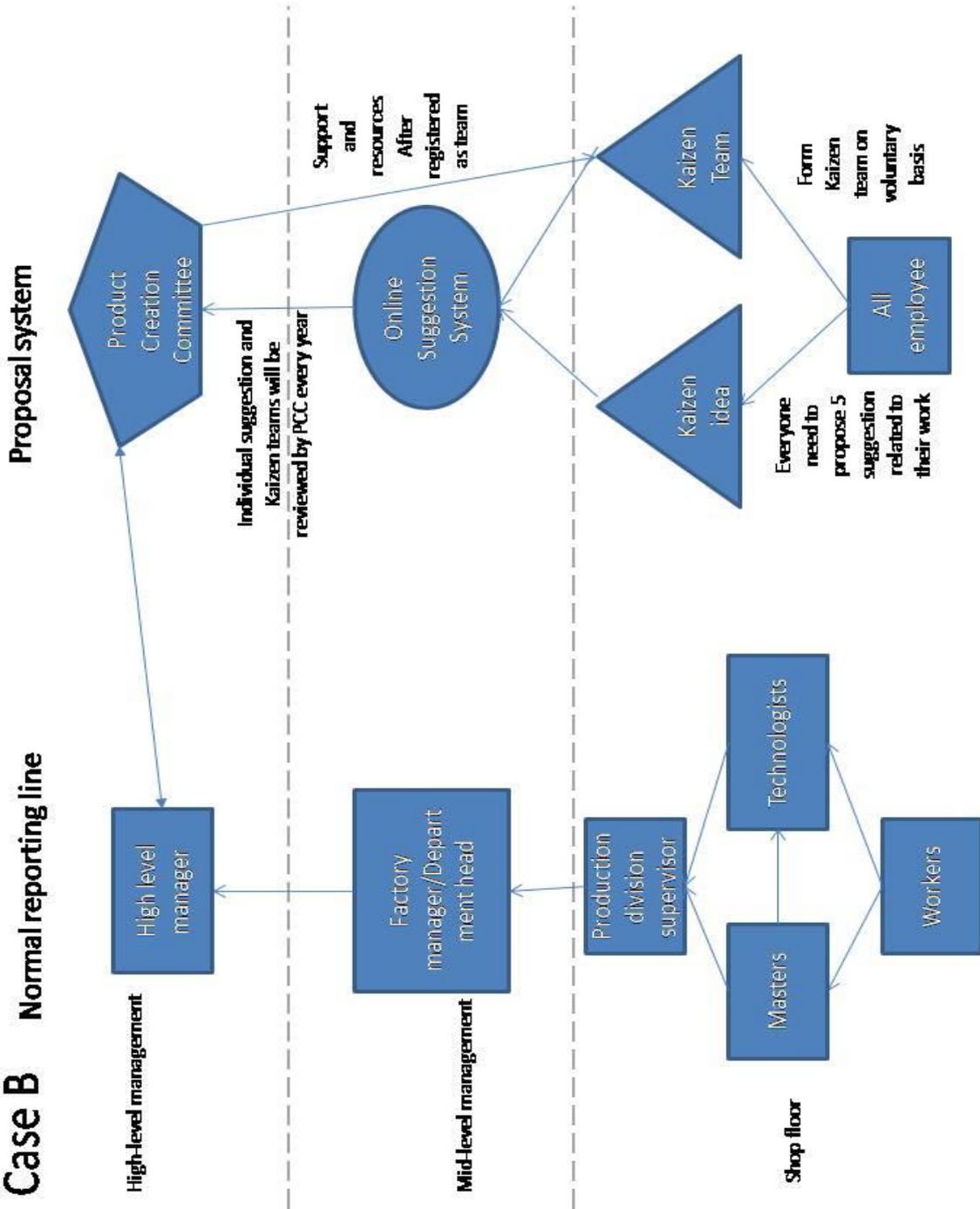
5			Deputy Head of New product development Depart.	A-DHoNPD		
6		Employee	CNC operative	A-CNC		
7			Low level engineer	A-LLE		
8			Quality control personnel	A-QC		
9	B	High	Member of board of shareholder	B-BM		
10				Vice president	B-VP	
11				Chief engineer	B-CE	
12		Mid	Head of production Depart.	B-HoP		
13	C	High	Vice President	C-VP	In charge of total R&D in Company C, supervisor of Chief Engineer	
14				Secretary of shareholder board	C-SSB	Representing a member of board of shareholder
15				Party Secretary	C-PS	In charge of internal university
16		Mid	Administrative manager	C-AM		
17				Director of employee training department	C-DoT	
18			Employee	Assistant of Administrative manager	C-AoAM	Worked two years in production department as management trainee
19	D	High	CEO	D-CEO	He is the biggest shareholder of Company D	
20				Vice president	D-VP	
21				Chief engineer	D-CE	
22		Mid	Head of production depart.	D-HoP		
23			Head of Quality Control Depart.	D-HoQC	The one who design BUL system for Company D	
24			Deputy Head of Sales Depart	D-DHoS	Worked as production worker for many years before	
25		Employee	CNC operative	D-CNC		

26	E	High	Vice president	E-VP	
27			Chief engineer	E-CE	
28		Mid	Deputy Head of Production Depart.	E-DHoP	
29		Employee	CNC operative	E-CNC	
30	F	High	CEO	F-CEO	
			Party Secretary	F-PS	
31			Chief Engineer	F-CE	
32		Mid	Head of Production	F-FoP	
33			Head of Quality control	F-HoQC	
34	G	High	CEO	G-CEO	This company is small so do not have many high-level managers
35		Mid	Head of R&D depart.	G-HoR&D	Serve as Chief Engineer
36			Head of Assembly division	G-HoA	
37			Head of product servicing department	G-HoPS	This department maintain products for customers

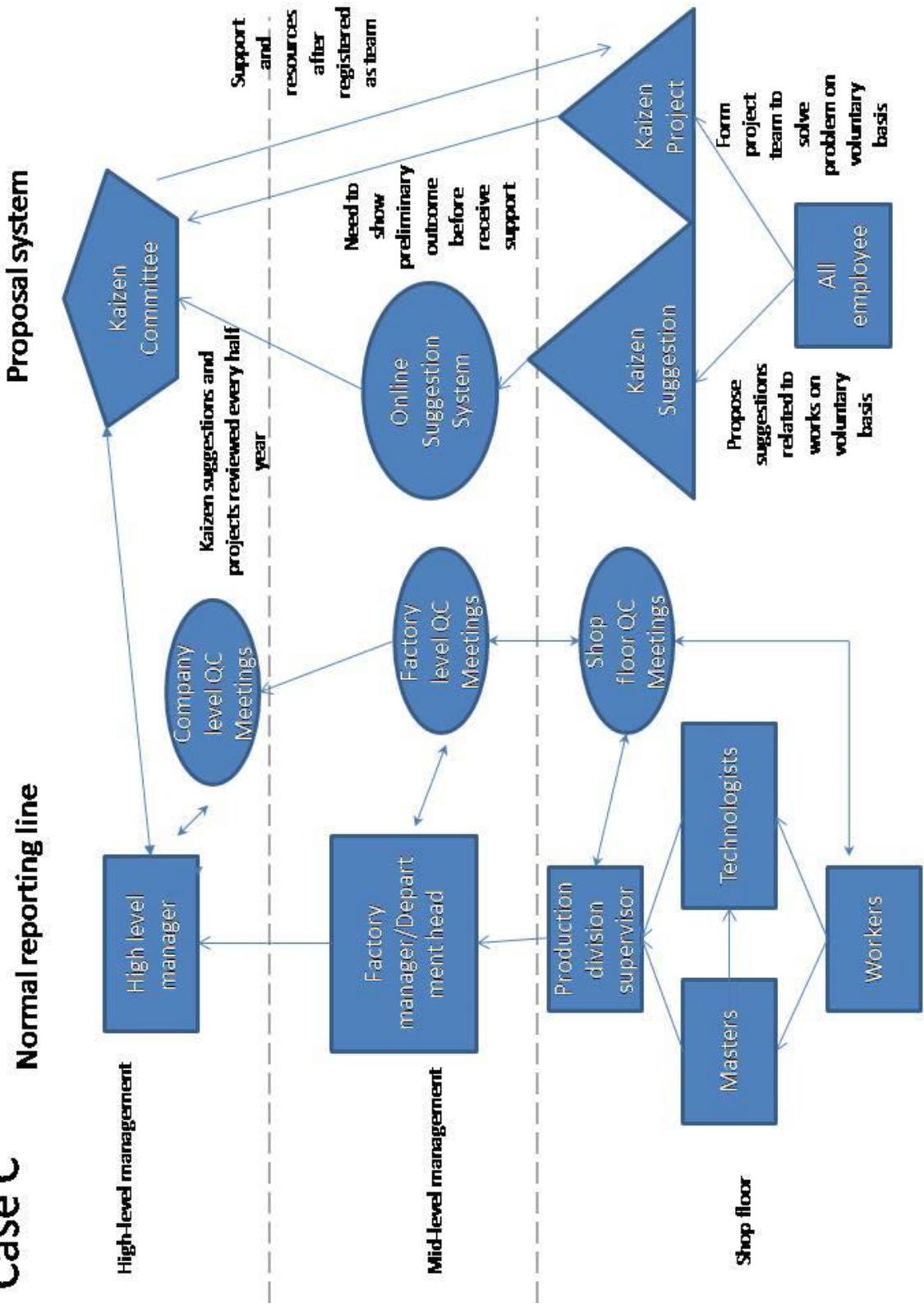
Appendix D: Flow Chart of Proposal Systems in Seven Cases



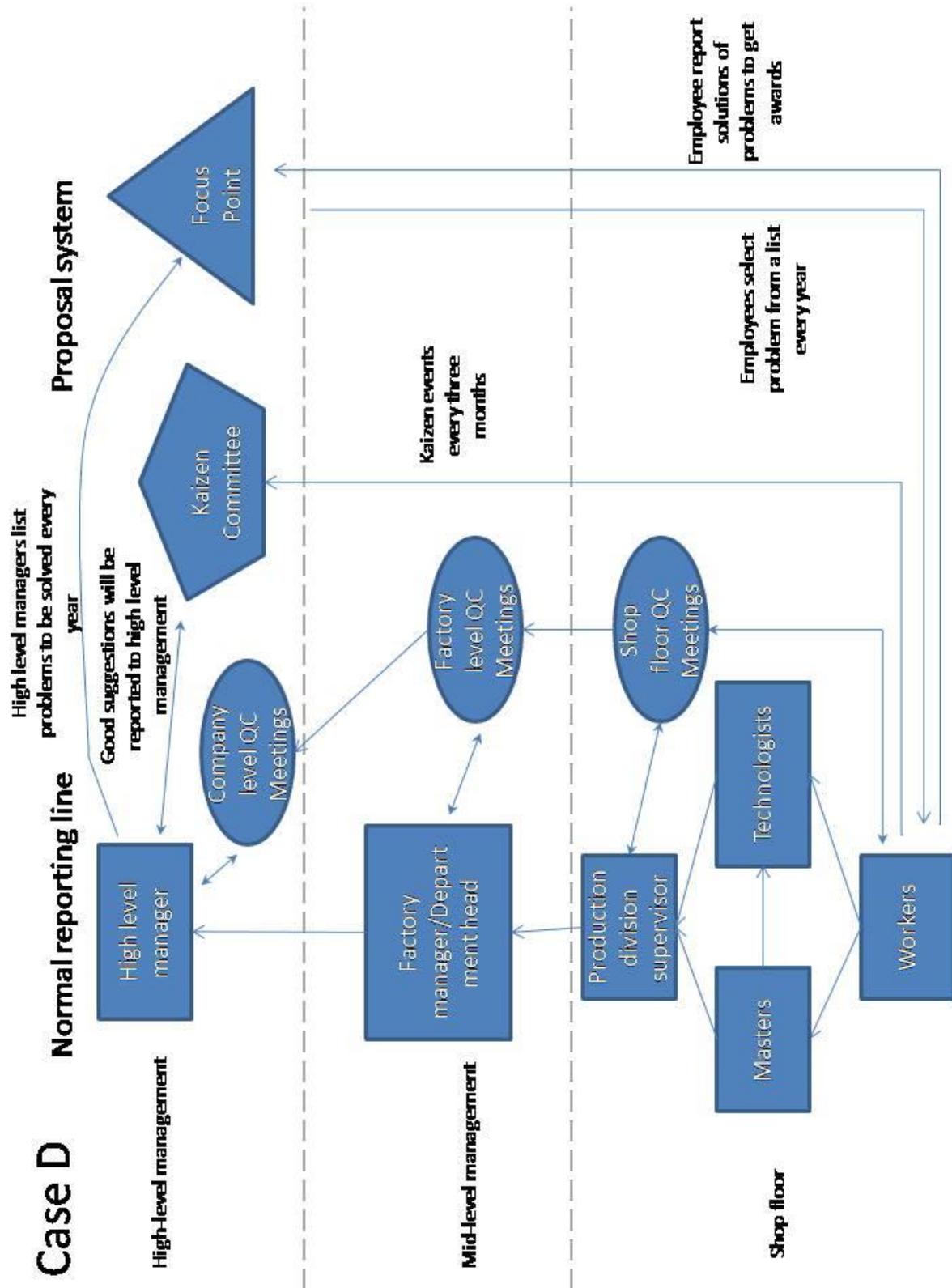
Case B



Case C



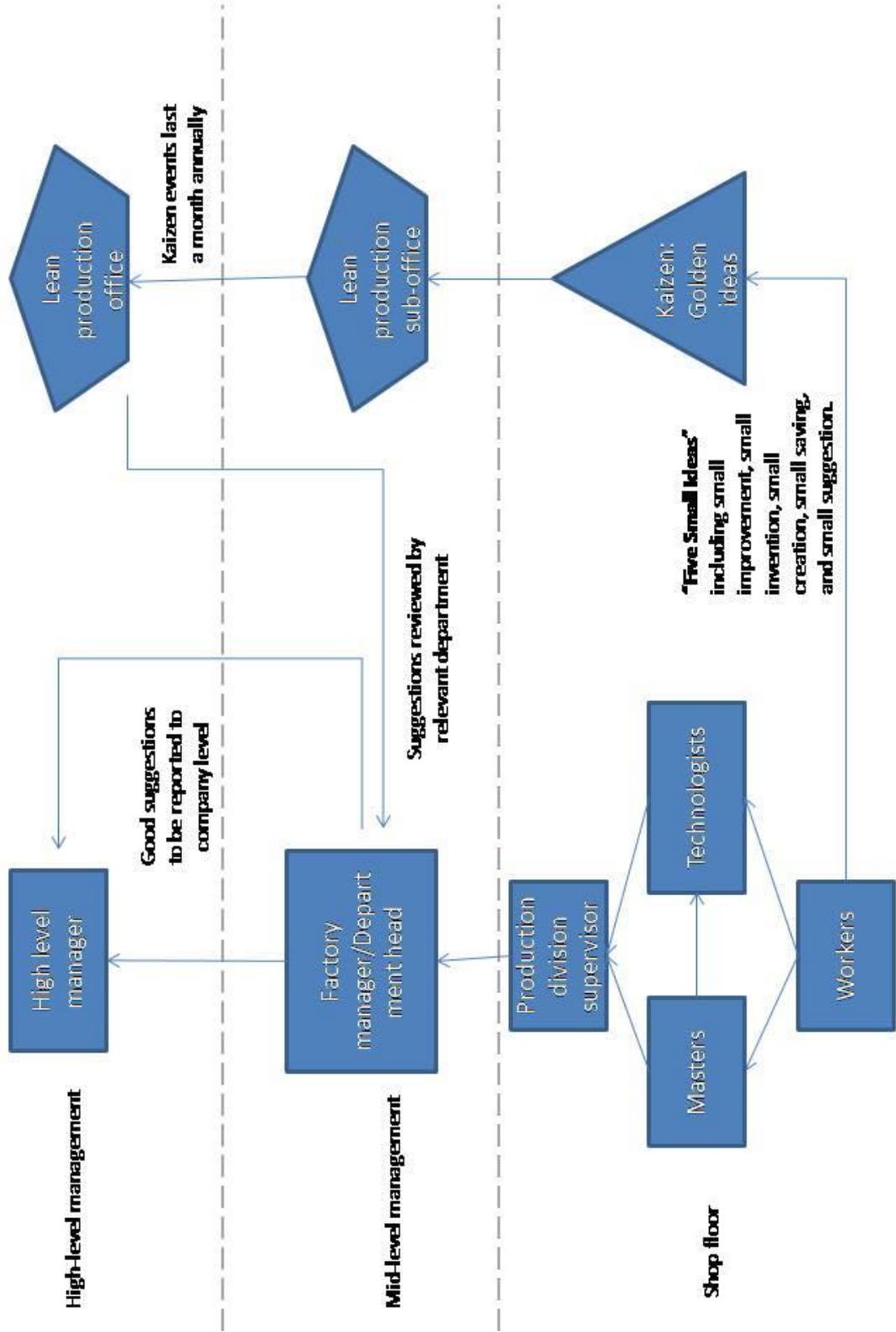
Case D

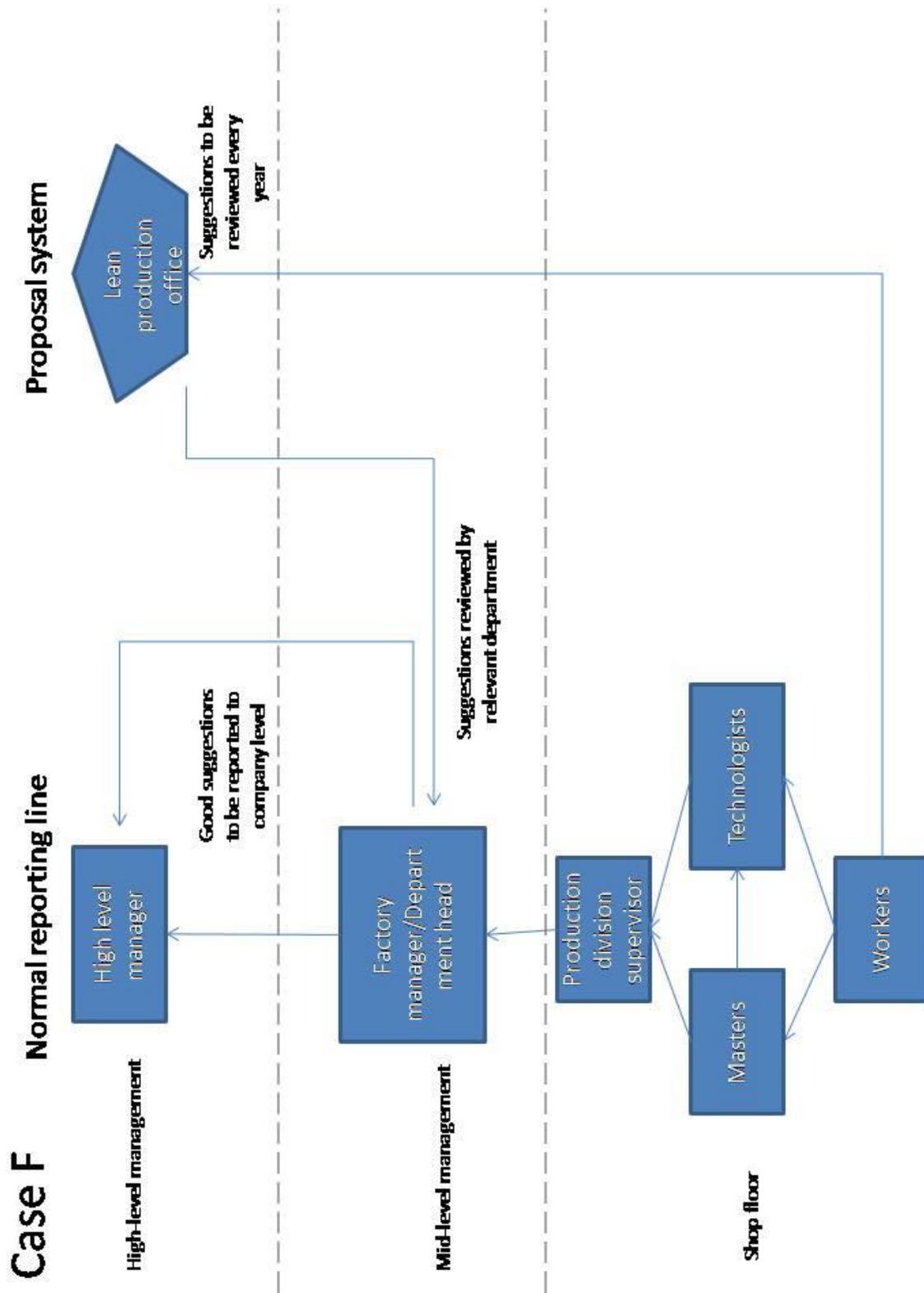


Case E

Normal reporting line

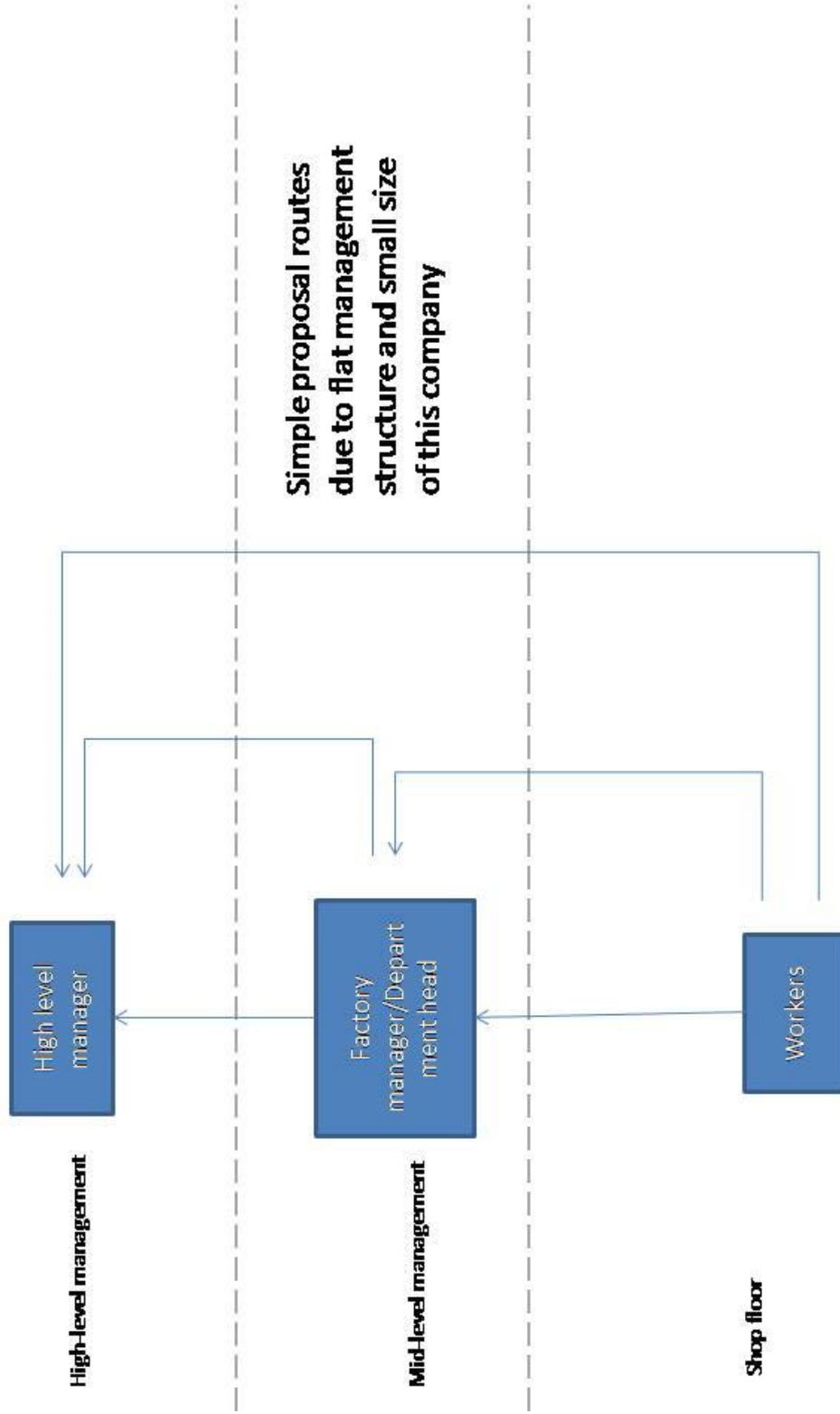
Proposal system





Case G

Normal reporting line



Simple proposal routes
due to flat management
structure and small size
of this company

