INTERNATIONAL TECHNOLOGY TRANSFER IN THE CHINESE COAL MINING INDUSTRY

QI, LI

李琦

Thesis Submitted for the Degree of
Doctor of Philosophy

PHD in Management

NEWCASTLE UNIVERSITY
FACULTY OF HUMANITIES AND SOCIAL SCIENCES
SCHOOOL OF BUSINESS

May 2013

Declaration

I hereby declare that this thesis submitted for a Doctor of Philosophy degree at Newcastle University is my own work except as cited in the references. I also certify that the efforts that have been made have not been previously accepted for any degree and are not concurrently submitted in candidature for any other degrees or institutions.

Signature:

Name: Qi, Li

Date: ________

Acknowledgements

My deepest gratitude goes first and foremost to my supervisor, Dr. Neil Alderman from the School of Business, for his continuous support, encouragement and guidance during my years of study. Without his consistent and illuminating instruction, this study would not have reached the present form. It is his brilliant ideas and expertise that led this study to its successful outcome. My gratitude and thanks also go to my ex-supervisors for their inspirational guidance.

I would also like to express my appreciation to China State Administration of Coal Mine Safety and those who gave me their precious time to share their experience with me, which enabled me to complete this study.

I should finally express my heartfelt appreciation to my beloved parents, who have always been by my side to inspire me and add courage without a word of complaint.

Abstract

This study investigated international technology transfer (ITT) of the coal mining industry in the Chinese context, and it focused primarily on how to achieve successful ITT by identifying affecting factors. The coal mining industry, as a dominant industry in China, hopes to achieve technological innovation and leapfrogging by ITT, because innovation distinguishes a leader from a follower and followers will have to continue purchasing technology from leaders. ITT is a complex process and many factors affect its success, so understanding of the affecting factors facilitates the industry to sufficiently learn and absorb foreign technology to achieve innovation. A number of researchers have studied the ways in which ITT can be achieved successfully in contexts other than the Chinese coal mining industry. However, in the Chinese context, it is still relatively unclear what factors affect the effectiveness of ITT.

Owing to the scant literature on ITT in the industry, a pilot case studies was firstly designed and conducted with involvement of the following three types of coal mines: large state-owned, local state-owned and small coal mines. Then a main case studies was designed through observing these types of coal mines and conducting eighteen in-depth semi-structured interviews with general managers, general engineers and directors from the respective three coal mines. The aim of the design is to develop a substantial theoretical framework for generating hypotheses by combining extant literature with the findings of the pilot case studies. In addition, a self-completion questionnaire was designed based on findings from the case studies and then administered through a web-based survey in order to test hypotheses and identify the affecting factors. 629 questionnaires were collected from large stated-owned coal mines and they were analysed by multiple linear regression. Design of the survey enables the researcher to generalize the qualitative findings beyond the specific case. Data from the case studies and survey were used to triangulate perspectives and

findings.

The main finding of the research revealed that the Chinese government made relevant safeguard regulations and punished IPR violation, which facilitated ITT. However, the government drew up encouragement policies and innovation strategies blindly based on its own visions or goals rather than the practical situation of coal mines; a number of managers of the coal mines interfered excessively with learning activities even without relevant background knowledge; and these interventions resulted in poor ITT performance. Furthermore, the large state-owned coal mine as transferee owned relevant background knowledge and provided relevant training to staff as well as building a good learning environment and establishing efficient team learning, which improved the effectiveness of its ITT.

The theoretical contribution of this study lies in filling gap in the ITT literature in China and tested the generalisability of the existing theories. The findings suggested that a number of extant theories are not applicable to the Chinese context. In order to make extant theories better 'fit' into the Chinese context, this study suggests modifying extant theories based on government, technology management and team learning, which are three controllable and vital dimensions affecting the effectiveness of ITT in the Chinese coal mining industry.

Key words: International Technology Transfer, Coal Mining Industry, Affecting Factors, Effectiveness of International Technology Transfer

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

TT: Technology Transfer

ITT: International Technology Transfer

IPR: Intellectual Property Right

FDI: Foreign Direct Investment

R&D: Research and Development

CBM: Coal Bed Methane

DEDICATION

To my dearest dad and mum, and all of whom have made me what I am today.

Thanks for your help, support, encouragement and belief in me through the years.

Prologue

"科技是第一生产力"

(Science and technology constitute a primary productive force)

---------- 邓小平 (Deng Xiaoping)

"Innovation distinguishes between a leader and a follower"

（领导者和追随者最大的区别在于创新）

---------- Steve Jobs

Chapter One – Introduction and Overview

1.1 Introduction

International Technology Transfer (ITT) has been a widely studied topic in academia since the 1960s; many researchers believe that ITT can help developing countries to shorten the technology gap with developed countries, enjoy the latecomer advantage and achieve technology leapfrogging. A number of research projects have studied how to achieve successful ITT based on the extant context, however, in the Chinese context, it is still relatively unclear what factors affect effectiveness of ITT. Consequently, it is necessary to conduct this study in order to identify and explore the factors that impact the effectiveness of ITT in the Chinese context as well as to test generalisability of extant ITT theories.

This study investigated the ITT of the coal mining industry in the Chinese context, the research focused primarily on how to achieve successful ITT through identifying affecting factors in order to strengthen the advantages and avoid disadvantages of the transferee.

This chapter starts by outlining the problems and context, then introduces the aims and objectives of the research, defines the scope of this study, evaluates the significance of the research, and finally, outlines the structure of the thesis.

1.2 Statement of Problems and Context

BP Statistical Review of World Energy (2011) showed that China's coal production and consumption accounted for 48.3% and 48.2% of the world's production and consumption respectively in 2010. Analysis by the BP Statistical Review of World Energy (2012) reveals that about 49.6 percent of energy consumption in China was provided by coal in 2011. Future energy consumption is also expected to rely heavily on coal, making the coal mining industry a dominant industry in China. Thus, its development and modernization remains a top priority on the national agenda. Owing to the long period of overexploitation of the Chinese coal mining industry, current coal mines have to mine deeper coal seams (over -1,000 meters), which accounts for 53% of the total coal resource. In addition, more than 70% of large state-owned coal mines have high gas content and gas outburst. It means that the Chinese coal mining industry suffers gas accidents more easily than other countries (Yuan Liang, Academician, Chinese Academy of Engineering, 2010).

According to data from the China State Administration of Coal Mine Safety (2012), the Chinese coal mining industry is responsible for more than six miners' deaths on average each day in 2010, which accounted for about 70 percent of the world's coal mining casualties. The main cause of fatalities is gas explosions. The methane stored in the coal seam could be released into the air in the process of coal mining; when methane takes up between 5 percent and 16 percent of the air and meets fire, a gas explosion occurs. In addition, in order to achieve safe production, most Chinese coal mines release methane directly into the air through the ventilation system while mining. China, as the country of the highest methane emissions in the world, accounts for 40% of global emissions; this will jump to 45 percent of global emissions in 2020 if China does not take measures to control methane emissions (Hexun, 2011). Methane is essentially a gas which is twenty times higher than carbon dioxide in terms of its greenhouse effect and ten times higher in terms of the ability of breaking the ozonosphere. Therefore, solving the gas problems has been regarded as the biggest challenge that the Chinese coal mining industry is facing.

The former Chinese Premier Wen Jiabao (2005), with a background in mining engineering, pointed out that to solve the gas problems, coal mines need to utilise the technology of coal-bed methane (CBM) drainage to drain methane before mining the coal seam. The technology can reduce the gas contents of underground working tunnels effectively. Generally, there are two main ways for coal mines utilizing the technology: technology innovation and technology transfer.

Firstly, technology innovation is independent R&D by coal mines. The current independent R&D capability of the Chinese coal mining industry is relatively weak. This can be attributed to the historical reason that when P.R. China was established in 1949, the USA and UK adopted the policy of 'blockade and embargo' and Cold War in the early stage of the P.R. China's establishment. China also experienced three years of serious natural disasters from 1959 to 1962, and a decade of the Cultural Revolution when all scientific and technological activities ground to a halt. Research institutes and universities were only reopened in 1977. Since 1978, the Chinese government has changed its main focus from political revolution to science and technology development. It means that China has only had three decades of development. This implies that the independent R&D capability of the Chinese coal mining industry lags behind developed countries and domestic technology cannot solve the gas problems effectively (Yuan, 2010).

Secondly, technology transfer can be called 'international technology transfer' when the technology has been transferred between countries. With the vigorous development of science and technologies today, it is impractical for coal mines of developing countries to rely on independent technology R&D and innovation to solve all problems. ITT as a shortcut is able to help a developing country to reduce the cost and risk of independent R&D

technology, promote technology level and gain competitive advantages. In addition, technology transfer is the basis for technology innovation, transferees usually utilize transferred technology to innovate and develop new technology in order to gain sustainable competitive advantage (Lihua, 2006).

ITT has been studied by academics since the 1960s (Alkhafaji, 1986). Owing to ITT involving politics, economy, trade, culture, technology, law and so on, each researcher studied ITT from a different standpoint. Despite 50 years having passed now, theories of ITT have still not formed a complete and independent system (Xu, 2007). Most research focuses on foreign direct investments, joint ventures, transfer models and economic developments. Existing research lacks an integrated relationship among different theories. A number of ITT theories are unilateral and dispersed (Xu, 2007). Most researchers overemphasize the geography, culture, economy, intellectual property rights and business affecting the effectiveness of ITT, and ignore the government, technology management and multiple levels of learning also affecting ITT. China, as the largest transferee of ITT in the world, is still unclear on how to achieve good ITT effectiveness. For example, five large state-owned coal enterprises in five provinces of China transferred the CBM drainage technology from Australia to solve gas problems in 2003, but they have not achieved the expected effect. After much unsuccessful ITT, there is little relevant research in China to investigate factors that affect the effectiveness of ITT. Consequently, this study will systematically and deeply answer research questions in order to fill in the theoretical and practical gap, and analyzed observation and interview data will be presented following the themes of analytical framework (presented in Figure 1.1).

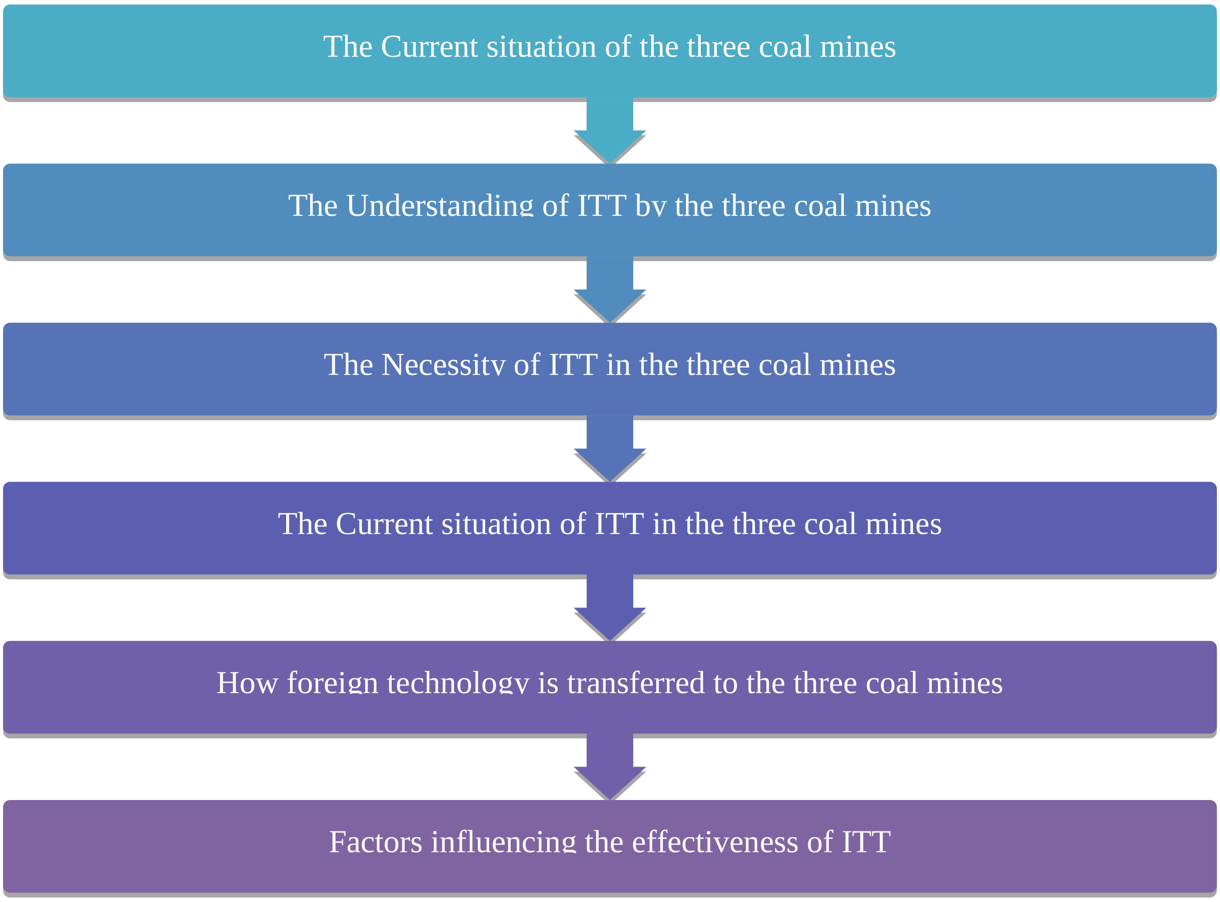


Figure 1.1 The themes of the analytical framework

1.3 Aims and Objectives

The primary aim of this research is to investigate and identify factors that impact the effectiveness of ITT in the coal mining industry in China. In order to conduct empirical research and achieve the aim of this study, four practical objectives were outlined as shown below:

1. To obtain an in-depth understandings of the concept, channels and necessity of ITT in the Chinese coal mining industry;
2. To identify the factors affecting the effectiveness of ITT in the Chinese coal mining industry by using the case studies and the structured survey;

3. To identify the implications of the relationship between the affecting factors and ITT effects;
4. To develop a theoretical framework by critically examining the extant ITT theories.

1.4 Defining the Scope of the Study

In this study, ITT is concerned with the recipient acquiring technology from the transferor. Transferors are usually foreign enterprises; recipients are usually Chinese state-owned coal mines and small coal mines. Chinese coal mining consists of two main forms: strip mining and underground mining. Since most Chinese coal resources need to adopt underground mining, in this study, coal mining is concerned with underground mining where engineers and miners search and move underground coal to the surface; its mining tunnels are dug far below the ground surface. The Chinese coal mining industry refers to state-owned coal mines and private coal mines to exploit the underground coal resource.

This study focused primarily on the effect of the ITT of the recipient rather than the transferor, because Chinese coal mines usually play the role of the recipient in the process of ITT (Wang, 2010). The evaluation of the effect of ITT focused on evaluating the effect of absorption and innovation of the transferred technology, which has been divided into the following five levels by the China State Administration of Coal Mine Safety (2011):

- Very good effect, means that the coal mine sufficiently absorbed knowledge involved in transferred technology, and achieved the expected effect and innovation based on the absorbed knowledge.
- Good effect, means that the coal mine sufficiently absorbed knowledge involved in transferred technology, and achieved the expected effect.

- Barely acceptable effect, means that the coal mine partially absorbed knowledge involved in transferred technology, and partially achieved the expected effect
- Poor effect, means that the coal mine partially absorbed knowledge involved in transferred technology, and no expected achievement was made.
- Very poor effect, means that the coal mine cannot absorb knowledge involved in the transferred technology, and no expected achievement was made.

1.5 Significance of the Research

This section explores the significance of this study after introducing the research context and defining the scope of the research. The original contribution of this study to knowledge consists of theoretical and practical contributions. The theoretical contribution of this study is the demonstration that the government, technology management and team learning are three controllable and vital dimensions influencing the effectiveness of ITT. This current research developed a theoretical framework to fill the theoretical gap in the field of ITT in the Chinese coal mining industry. This research also revealed the relationship between 14 different factors and ITT effects. Findings of this study further implicate that the coal mine engaging in ITT needs to take affecting factors or pre-conditions into account. The research adopted extant theories to investigate the ITT of the coal mining industry in the Chinese context. This means that the generalisability of extant theories will be further tested in this study, which provides a theoretical basis for further research. Practically, this study contributed to extant literature concerning the ITT on licensing. This research also helps managers of coal mines to predict the effect of ITT. This study further assists the recipient to more accurately evaluate the value of ITT based on characters of the transferee rather than previous experiences. The findings of the research may have implications for government policy makers who are trying to use the current policy system to improve the effectiveness of ITT.

1.6 Structure of the Thesis

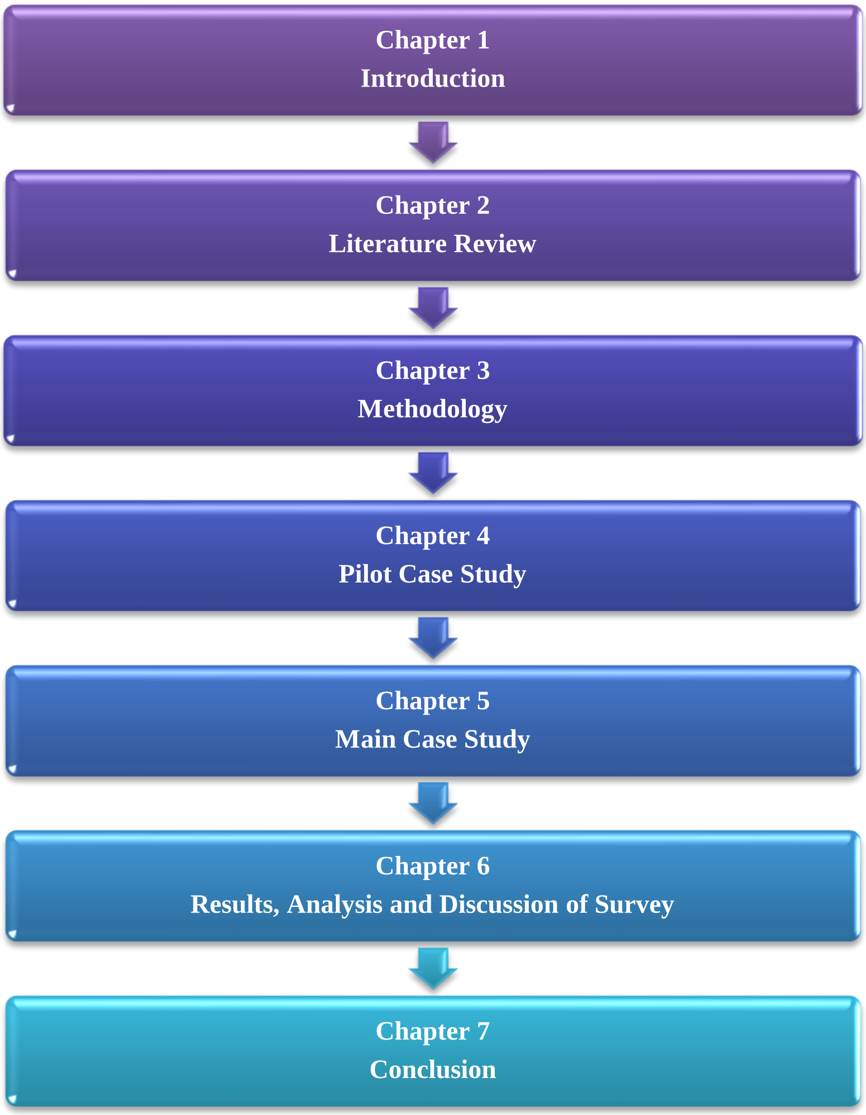


Figure 1.2 Structure of the thesis.

Figure 1.1 presents the structure of the thesis in seven chapters. Chapter one is an overview of this study. Based on the problems and context, the aim and objectives of this study are presented and the significance of the research is assessed. In chapter two, the existing literature and empirical studies are critically reviewed in terms of factors affecting the effectiveness of ITT through introducing the concept of ITT and examining the various ITT theories. A theoretical framework is developed in order to map and locate a systematic approach to investigate what factors affect the effectiveness of ITT. The channel, necessity, history and current situation of ITT in the Chinese coal mining industry is discussed in this chapter. Within the chapter, US coal mining industry ITT is compared with the Chinese coal mining industry ITT in order to learn the advantages and avoid the disadvantages. Detail of research methodology is presented in chapter three, which consists of research philosophy and paradigm, choice of research strategy, rationale of research design and data collection tools, detail of data analysis, validity and reliability. Initial findings from the pilot case studies are presented in chapter four, which is a general understanding of the process and the current situation of ITT in the Chinese coal mining industry as well as factors influencing the effectiveness of the ITT. The pilot study helps the researcher to test and refine the research questions in order to accurately conduct the main case studies and avoid the appearance of leading questions. Chapter five presents the analysis results of the main case studies and develops six hypotheses. The findings of the survey are analyzed and discussed in chapter six. Six hypotheses are tested and affecting factors are identified within the chapter. Comparison between the findings from this study and previous research is also described in the chapter in order to examine differences between the current study and previous research as well as to consider possible explanations for the analysis result and understand generalisability of extant theories. A regression model is presented in order to predict the effect of ITT base on indicators. Finally, with all findings, contributions to knowledge, implications and limitations of this study, recommendations and the conclusion are presented in chapter seven.

Chapter Two – Current State of Knowledge of ITT

2.1Introduction

ITT in China has been a widely studied topic in academia since the 1980s. A great number of studies have focused on manufacturing, construction and other industries to study factors that affect ITT, but few researchers studied the ITT of the coal mining industry. It can be deduced that there is still a lack of clarity about what factors affect the effectiveness of ITT in the coal mining industry in the Chinese context. Therefore, it is necessary to conduct the study to test the generalisability of extant theories and to evaluate theories on whether they fit the context of the Chinese coal mining industry.

This chapter aims to gain a holistic understanding of ITT through reviewing relevant literature. It starts with a discussion of concepts of technology, technology transfer and knowledge transfer. The discussion then moves on to evaluate the potential factors affecting the effectiveness of ITT, and channels of ITT as well as ITT in the Chinese coal mining industry. The Chinese coal mining industry and the US coal mining industry are then compared from the perspective of ITT in order to better understand and learn the US's advantages. Finally, a theoretical framework will be established and used in understanding the basic theoretical concept of ITT.

2.2 Definition of Technology

Understanding technology's definition is a vital step for its transfer. The concept of technology has to be addressed prior to the explanation of technology transfer (Lihua and Khalil, 2006; Odigie, 2012). Technology represents the combination of human understanding of natural laws and phenomena accumulated since ancient times to make things that fulfil our need and desires or that performs certain functions (Karatsu, 1990). In other words, technology creates things that benefit human beings. Miles (1995) points to technology as the means by which we apply our understanding of the natural world to solve practical problems.

Mnaas (1990) and Lihua and Khalil (2006, p.11-12) consider that technology consists of four closely inter-linked elements, including technique, knowledge, organisation and product.

- Technique covers the instruments of labour (machinery and tools), materials and the way they are brought into function by labour in the working process. Both social dynamic (working process) and social contradictions (e.g. between machinery and labour) are inherent in this element of the technology as in each of the sub-concepts.
- "Knowledge consists of three principal categories: applied science, skills and intuition. The weighting between these categories of knowledge is changing historically, but in every case an adequate combination of types of knowledge must be present". Knowledge is the "key to control" over technology as a whole, which can be seen both at micro-level (Taylorism) and at higher levels of social aggregation (technological dependency). However, it is helpful for understanding that knowledge can be classified as explicit knowledge and tacit knowledge (Lihua and Khalil, 2006, p.11-12).
- Organisation refers to the fact that technique and knowledge must be organised before they can bring results. Organisation is, therefore, an integral part of technology. Organisation of a working process of technique and knowledge into a product may have technical causes, but mostly the actual choice of organisation will rest widely on social-economic causes and reflect the general social structure of society.
- Product concerns the ultimate purpose of bringing technique, knowledge and organisation together, that is, to obtain a product. Without this goal, it is difficult to understand the other three elements properly. It seems natural to include the product in a

> comprehensive technology concept, not least because in practice, the choice of product often precedes the choice of the technique, knowledge and organisation by which it is going to be produced (Lihua and Khalil, 2006, p.11-12).

It should be noted that knowledge is a key to control technology as a whole. Galbraith (1967) defined that technology was systematic application of organised knowledge to practical tasks. Dosi (1984) considered technology as a set of segments of knowledge containing directly practical and theoretical know-how, procedures and experiences that also comprised the knowledge and skills of participants of an organisation. De (2004) indicated that technology as ensemble of theoretical and practical knowledge, as well as skills, that were used by firms to develop and produce its goods and services. The UN Conference on Trade and Development (UNCTAD, 1987) defined that technology is bought and sold as capital goods including machinery and productive systems, management and specialized scientists, information of both technical and commercial character, including that which was readily available and that subject to proprietary rights and restrictions. Lihua and Khalil (2006) pointed out that technology was system knowledge in order to achieve special purposes (includes explicit and tacit knowledge).

In reviewing the above definitions, the author considers Lihua and Khalil's definition is more sophisticated than other scholars because their definition presents the most essential characteristics of technology. Therefore, technology in this study is defined as the systematic knowledge for achieving special purposes and it includes explicit and tacit knowledge. Detailed discussion of explicit and tacit knowledge will be presented in section 2.4.

2.3 Definition of Technology Transfer

Concerning the definition of technology transfer, there is no unified definition as the two words ‘technology’ and ‘transfer’ seem to convey different meanings by different people and different organisations. The author considers that it is necessary to clarify the definition of ITT in this study, since a number of Chinese scholars define ITT as an international technology trade. The author argues that the effect of ITT may be improved when governors and senior managers understand the meaning of ITT and how it works in the Chinese context. Kayak (1985) considered that technology transfer as the transition of know-how to suit local conditions. Fransman (1986) pointed out that technology transfer as acquisition of knowledge through transformation of input into output. Stewart (1987) further considered that technology transfer as the utilization of existing techniques in an instance where it had not previously been used. Bachtler (1991) argued that technology transfer was conceptualized as a flow of technology from an innovator to a user in a situation where the technique had not been used. In this case, the end-user could be individuals, a company, an industry and a country. It is a target-driven learning and developmental process through interactive channel in most cases. United Nations Conference on Trade and Development (UNCTAD, 2001) indicated that technology transfer as the transfer of systematic knowledge for the manufacture of a product or provision of service. Abott et al (2007) considered that technology transfer as movement of know-how, technical knowledge from one organisation to another.

The current research adopted the definition which is proposed in the 2001 United Nations Conference on Trade and Development (UNCTAD). It has defined ITT as the transfer of systematic knowledge between different countries’ organisations for achieving a special purpose. The definition is more sophisticated than other scholars proposed because it presents the most essential characteristics of ITT.

Lihua and Khalil (2006) further pointed out that knowledge transfer is crucial and is the fundamental element of ITT. Therefore, section 2.4 will discuss more detail on knowledge transfer.

2.4 Technology Transfer and Knowledge Transfer

Lihua and Khalil (2006, p.12) argue that "without knowledge transfer, technology transfer does not take place, since knowledge is the key to control technology as a whole". Hamel (1999) considers that the competitive advantage of an enterprise mainly relies on the knowledge that it owns. Grant (1996) and Liebeskind (1996) further point out that a firm's most valuable resource is knowledge, including intangible assets, routines, and creative processes that are difficult to imitate. "Knowledge is also widely recognized as the most important factor in creating and sustaining superior organisational performance" (Lihua and Khalil, 2006, p.12).

Moreover, in the current turbulent world, "both public and private sector organisations face the environment characterized by rapid and unpredictable change. Customers and clients are demanding more, and in the private sector, businesses face hyper-competitive markets and industries. Under such circumstances, the only way that organisations can build and sustain competitive advantage is to create or accumulate knowledge more rapidly than their competitors (Lihua and Khalil, 2006, p.12)". It owns more productive and competitive capability than competitors in competition if the enterprise is good at knowledge transfer (Argote and Ingram, 2000).

Galbraith (1990) points out that one of the key reasons to enterprise success lies in the efficient exploitation and the transfer of knowledge-based assets. Indeed, a technology transfer project is essentially a knowledge accumulation task, which Gupta and Govindarajan (2000) further disaggregated into knowledge creation, acquisition, and retention (Daghfous, 2004), in another words, knowledge transfer.

Since Teece (1977) has proposed the concept of knowledge transfer, various scholars have posed different definitions about knowledge transfer. Wiig (1997) regards knowledge transfer as a systematic process, including acquisition, organisation, restructuration, storage or memory, re-packaging and diffusion of knowledge. Research Councils UK (RCUK, 2006) further considers knowledge transfer as the two-way transfer of ideas, research results, expertise or skills between one party and another that enables the creation of new knowledge and its use in the development of innovative products, processes and/or services. This research defines that knowledge transfer is the process in which the transferor transfers knowledge to the recipient, and the transferred knowledge is integrated into the organisational operation of the recipient.

Polanyi (1967) considers human knowledge starting from the fact that we know more than we can tell. Knowledge is increasingly being recognised as a vital organisational resource that gives market leverage and competitive advantage (Leonard-Barton, 1995). In particular, knowledge has become a substance to be 'managed' in its most literal sense. In general, knowledge consists of two significant components, involving explicit knowledge and tacit knowledge (McAulay et al., 1997). Explicit knowledge includes documents, drawings, calculations, designs, databases, procedures, manuals, audio and video. Tacit knowledge refers to experience, technique, culture and habit (Lubit 2001). In comparison, explicit knowledge is more precise and systematic, and it can be recorded and communicated in the form of literature or codified procedures. Tacit knowledge is not available as a text and may be regarded as residing in the heads of those working in a particular organisational context. It involves intangible factors embedded in personal beliefs, experiences, and values (Pan and Scarbrough, 1999). Hence, explicit knowledge is relatively easy to transfer, while tacit knowledge is not. However, the greater the extent to which a technology exists in the form of less physical resources, the greater proportions that tacit knowledge contains. Therefore, tacit knowledge transfer is the key to technology transfer.

Tacit knowledge is not easily shared due to its inherent character. Effective transfer of tacit knowledge generally requires extensive personal contact and trust. Tacit knowledge is not like transferable language, text, graphics or symbols that can be clearly expressed. It is very difficult to express logically, and it is a non-verbal intelligent activity. Tacit knowledge exists in the minds of individuals, and it cannot transfer through the formal form. For example, in school education, tacit knowledge owners are difficult to express to the recipient. But it does not mean that tacit knowledge cannot be transferred; tacit knowledge can only be transformed into explicit knowledge in certain conditions and channels, including job training and face-to-face communication at work. The key to tacit knowledge transfer is keeping channels unblocked. Odigie and Lihua (2008) considered that channel of tacit knowledge transfer could be unlocked through the following ways:

Direct key transfer: tacit knowledge is transferable by job training. This method of transfer is very effective. The transferor trains the transferee by teaching what is known as well as providing practical work while transferor is able to make corrections. Transferee are given project tasking to practice what they have leant (Odigie and Lihua, 2008).

Tea-break: tea-break is an informal way of transferring tacit knowledge. This method provides a forum where transferees and transferor can discuss over tea or at break period in a common room. This method develops social relationship between transferee and transferor thereby building trust and friendship. (Odigie and Lihua, 2008).

Discussion forum: this is a formal way of transferring tacit knowledge. Formal discussion forum should be created where both transferors and transferees discuss relevant issues relating to the job and their problems at the job. This type of forum provides room that transferee is able to ask direct questions. The transferor and the transferee can share a mutual vision in the process of discussion, and develop a knowledge-sharing culture (Odigie and Lihua, 2008).

Protection of intellectual property right: without strong IPR protection, transferor fears losing competitive advantage when they transfer tacit knowledge to transferee. It is not surprising that the transferor will block the channel of tacit knowledge transfer when IPR protection of recipient country is weak, because tacit knowledge delivers the most competitive advantage (Odigie and Lihua, 2008).

Polanyi (1967) considered that tacit knowledge was hidden behind explicit knowledge, and it was very difficult to make tacit knowledge explicit. This does not mean that tacit knowledge cannot be explicated, but only under certain conditions. Once tacit knowledge is articulated or converted into explicit knowledge, it becomes sharable among members in an organisation. The converted knowledge can then be internalised to enrich the existing tacit knowledge possessed by individual members (IRMA, 2011, p.1530). Figure 2.1 presents processes of knowledge transfer. The explicit knowledge and tacit knowledge from the transferor have been converted into explicit repository, in order to be understood by members of the transferee.

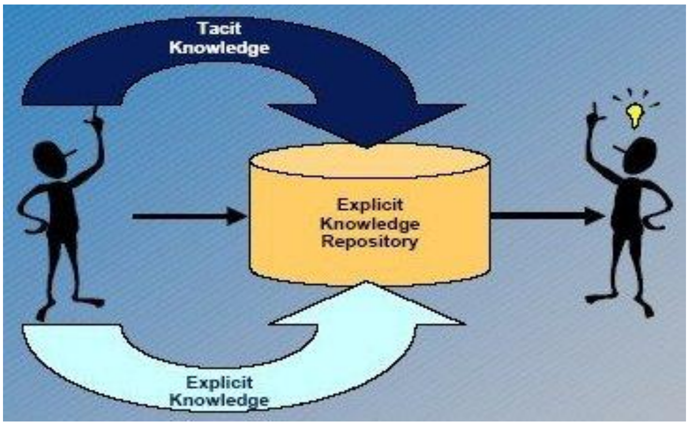


Figure 2.1 Process of Knowledge Transfer in Technology Transfer (Odigie and Lihua, 2008)

Maitland (1999) argues that the crucial factor in determining a company's competitive advantage is its ability to convert tacit knowledge into explicit knowledge through organisation learning. Therefore, organisation learning is vital in the process of technology transfer. The next section will discuss multiple levels of learning in an organisation.

2.5 Knowledge Transfer and Learning

Cutler (1989) states that technology transfer is the essential process of knowledge transfer, when an organisation learns knowledge from another organisation. The technology capability of the transferees can only be promoted when the transferred knowledge is integrated into the organisational operation through learning (Atuahene-Gima, 1992). Learning is the vital step when enterprises develop and accumulate technology resources (Harris and Mowery, 1990).

Learning in an organisation encompasses multiple levels (Beeby and Booth, 2000; Crossan et al., 1999; Nonaka and Takeuchi, 1995; Robinson et al., 1997). Levels of learning can be divided into individual, team, organisational, and inter-organisational learning. Knowledge transfer always takes place among the levels of learning in an organisation (Sun and Scott, 2005), but effectiveness of organisational learning is not equal to the sum of individual learning or team's learning effectiveness; it may be higher or lower than them. It mainly depends on sharing the degree of individuals' or team's know-how that it has been learned from transferors (Chang, 2005). In addition, Senge (1990) considers that organizational learning could have a significant impact on how knowledge is transferred. Because knowledge transfer and organizational learning are closely linked, it would be difficult to imagine that knowledge can be remodelled, expressed, created and used in an organisation without any learning behaviour (McInerney and LeFevre, 2000). Appropriate and effective organizational learning facilitates transfer of knowledge (Xu, 2007).

"It is widely agreed that learning consists of two kinds of activity; the first kind of learning is obtaining know-how in order to solve specific problems based upon existing premises; the second kind of learning is establishing new premises to override the existing ones" (Nonaka and Takeuchi, 1995, p.44). Zhou and Sun (2005) argue that the Chinese enterprises as transferees are more concerned about how to digest and absorb the transferred technology through effective learning, in order to solve practical problems and develop new technology.

Zhou and Sun (2005) further consider that the effectiveness of learning is affected by two aspects: learning object and learning subject. The former means characteristics of the transferred technology, and the latter means the learning capability of an organisation. The learning object is difficult to change and uncontrolled for all transferees (Tyre and Hauptman, 1992). Therefore, the effectiveness of learning mainly relies on the learning capability of an organisation.

The learning capability of each organisation is different. Organisational acquired knowledge may not be equal to the actual knowledge involved in the transferred technology, and the gap between the learned knowledge and the actual knowledge can be narrowed by promoting the learning capability of the organisation (Zhou and Sun, 2005). Chen et al (2009) further explain that the nature of the complexity of the transferred technology requires the transferee to provide the same level of learning capability. It represents the fact that the more complex source technology is, the higher capability the transferees need. Therefore, promoting the learning capability of organisation is an effective method for improving the effectiveness of knowledge transfer if there is a gap between the required learning capability and the existing learning capability (Zhou and Sun, 2005).

Zhao (2010) considers that the final objective of Chinese coal enterprises promoting learning capability is to innovate and develop new technology. Figure 2.2 presents the unique way that Japanese companies bring about continuous innovation, specifically the linkage between the outside and the inside. Knowledge which is acquired from outside through technology transfer and which is shared widely within the organisation is stored as part of the company's knowledge base, and is utilised by those engaged in developing new technologies and products (Nonaka and Takeuchi, 1995, p.6).

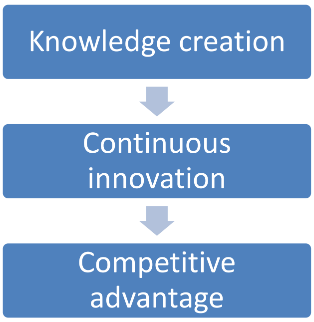


Figure 2.2 Japanese companies bring about continuous innovation
(Nonaka and Takeuchi, 1995, p.6).

Therefore, the next section will review the process of transfer, learning and innovation of technology.

2.6 Transfer, Learning and Innovation of Technology

ITT between developed and developing countries possesses strategic significance in science and technology (S&T) capacity building (Lihua and Xie, 2009). As stated by the President of China and General Secretary of Chinese Communist Party, China as a developing country was already aware that "real core technologies" cannot be purchased but can only be achieved by developing "indigenous innovation" (Hu, 2006). Therefore, President Hu Jintao (2006) pledged to build China into "an innovation-oriented country" by 2020. This means China is trying to become less reliant on foreign technology in the future. Zhao Tiecui (Minister, China State Administration of Coal Mine Safety, 2010) pointed out that ITT is only one kind of tool for promoting coal enterprises' technology capability, and technological innovation is the final objective of China's coal mining industry while engaging in ITT.

Wang and Zhou (1999) describe that the process of technology capacity building in Chinese enterprises is "transfer-digestion-absorption-innovation-dissemination" (see Figure 2.3).

Figure 2.3 Technology capacity building process of Chinese enterprises (Wang and Zhou, 1999).

In the process of technology capacity building, the author argues that learning plays a vital role from technology transfer to technology innovation. Indeed, the technological innovation process is a diversified learning process (Liu et al., 2008). Learning within and across organisational borders has a major impact on innovation. Learning may come from learning-by-using (Rosenberg, 1982), learning-by-doing (Arrow, 1962), and learning-by-interacting (Lundvall, 1985; Lundvall and Vinding, 2004).

Liu et al (2008) consider that the nature of organisational learning and technology innovation are consistent with each other. First of all, processes of learning and technology innovation are uncertain. One possible reason for the uncertainty of the processes of learning is that what needs to be learned about transforming technology and accessing markets can only become known through the process itself (Lazonick, 2005); the process of technology innovation is also uncertain because the evolution of technology contains great technical uncertainties, such as the uncertainty of technical standards and application, the uncertainty of the basis of scientific knowledge, functions and benefits, and the uncertainty of the technical lifecycle (Liu and Li, 2005). Innovation is inherently uncertain, so it is difficult to accurately predict the R&D cost and performance of a new technology (Pavitt, 2005). Secondly, Georghiou et al (1986) consider that both learning and technology innovation are cumulative processes, because what is learned today provides a foundation for what can be learned tomorrow, where firms' search for the future is heavily conditioned by what they have learned to do in the past. Also, technology innovation cannot be done all at once. Dosi (1988) considers that the change of technology is a cumulative process and depends on the previous experiences of the individual or organisation. Finally, Pavitt (2005) argues that both learning and technology innovation is a collective process. Since the specialised and professionalised nature of the knowledge is proliferating, and the learning process requires collaboration of different people with different capabilities, it is difficult to rely on a single individual to innovate independently.

Guan et al (2006) describe the technological progress trajectories for developing countries to catch-up with developed countries (see Figure 2.4). Firstly, developing countries acquire technology from developed countries through ITT, and then transferees absorb and improve transferred technology for achieving innovations. ITT already becomes a shortcut for developing countries to promote their technological levels and to achieve innovations (Lihua, 2008). In addition, the evaluation of the ITT process has generated the greatest interest among this field's researchers. They endeavour to discover what factors in the process affect the effectiveness of ITT, in order to help decision-makers to make sure whether it is feasible and to consider the value of ITT (Autio and Laamanen, 1995). Therefore, the next section will identify the factors that affect the effectiveness of ITT.

Figure 2.4 Technology progressive trajectories (Guan et al., 2006).

2.7 Factors Affecting the Effect of ITT

In the previous sections, the author has reviewed the theoretical development of technology transfer, transfer and learning of knowledge as well as the significance of ITT in developing countries. In order to obtain a more holistic and deeper understanding about ITT, the author argues that there is a necessity to identify factors related to the effects of ITT, because any organisation and people hope to achieve a good effect when they engage in ITT. However, the author has also noticed that there is no academic research on the factors affecting effectiveness of ITT in the Chinese coal mining industry in the last decade; most extant theories are based on other contexts or industries rather than the coal mining industry. Therefore, the author argues that there is a research niche through empirical research to test existing theories to evaluate whether they fit the Chinese coal mining industry, but this does not mean that these theories cannot be adopted in the industry; this needs to be critically reviewed and further tested through empirical research, because the theories and concepts related to ITT may have different meanings in different contexts.

Zhao and Reisman (1992) considered that technology transfer is a very complicated and interactive process between organisations. Spann et al (1995) point out that a number of researchers have presented conceptual, economic, mathematical, strategic marketing, communication-based, and integrative methods or models to measure processes, performances and effects of ITT. However, the results are usually deficient in standardisation and agreement, although the methods or models capture a variety of perspectives. These differences in perspectives, goals, and roles may contribute to the measuring of transferring progress, final success, and overall effectiveness (Lai, 2011, p.1219).

Kumaraswamy and Shrestha (2002) pointed out that the characteristics of transferor and transferee were essential elements to achieve successful ITT. Malik (2002) considered that achieving successful ITT needed two conditions: transferor was willing to transfer the appropriate technology and transferee had every intention to adopt it. Lin and Berg (2001) also considered that the degree of international experience of both the transferor and transferee were able to affect significantly on the ITT process. Fisher and Ranasinghe (2001) pointed out that the appropriateness of the transferor and transferee’s cultural traits for working in a partnership should be determined prior to embarking on the ITT process. This study was mainly based on transferees’ perspectives to improve the ITT effect through identifying potential influential factors in the process of acquisition and absorption of the transferred technology.

Sheng (2013) considered that knowledge stickiness and knowledge ambiguity as two main barriers affecting transfer of knowledge. Szulanski et al. (2004) pointed out that knowledge stickiness, or the inability or unwillingness to transfer knowledge, is one factor that keeps knowledge from flowing and had been cited as the major reason for knowledge transfer failure. Simonin (1999) also pointed out that knowledge ambiguity played a key inhibiting role in the process of knowledge transfer.

Cohen and Levinthal (1990) considered that knowledge absorptive capacity of an organization was its ability to understand and assimilate new knowledge and applied it onto new product development. It included an organization's R&D spending (Cohen and Levinthal, 1990; Fosfuri and Tribo, 2008; Lane et al., 2006; Todorova and Durisin, 2007), the number of patents (Tsai, 2001), its membership in the scientific community (Deeds, 2001), its knowledge management routines (Jones and Craven, 2000), its experienced workforce and enterprise owner (Lim and Klobas, 2000). An organization's knowledge absorptive capacity is a key factor affecting effect of ITT.

Lihua (2001) investigates ITT of the construction industry in China's three provinces within Sino-foreign joint ventures through structured survey. His findings show a significant association between ITT and economic development, which means that ITT is easily to achieve successfully when transferees' economic development is at the same level as the transferors. In other words, the ITT effectiveness of large state-owned coal mines should be better than that of small coal mines. For example, the coal output of a large mine is higher than the output of a small mine, and higher coal output means more profit and better economic development. It means that a large coal mine is able to invest more funding in technology R&D. It also means that a large coal mine has a small technology gap with a foreign transferor. Therefore, it is easier for large state-owned coal mines to acquire transferred knowledge and achieve a better ITT effect than small scale coal mines when two kinds of coal mines transfer the same technology from a foreign transferor. Madu (1989) and Lai and Tsai (2009) further support his argument, and they also consider that the size, the capability and the R&D level of the transferee as the main factors affect the effectiveness of ITT.

In addition, Ounjian and Carne (1987) consider that the transferor is a main factor that affects the effectiveness of ITT. Chen (1995) also argues that ITT will achieve a better result if there is good cooperation between the transferor and the transferee. For example, the transferor should fully fulfill the contractual obligations which provide relevant technology training courses and service to the transferee. Lai and Tsai (2009) further support Chen's argument, by considering the attitude of the transferor when supporting technology transfer activities, which affects the effectiveness of ITT.

Phaal (2001) argues that regarding effective technology management as a source of competitive advantage is vital for many organisations. Megantz (2002) considers that technology management is a vital dimension that affects the effectiveness of the ITT. Wu et al (2010) further support Megantz's argument. They argue that there is a potential problem in China's enterprises, in which they ignore the importance of technology management. For example, the absorption rate of the transferred technology is low and new technology is poorly handled.

In addition, Sun and Scott (2005) argue for individual, team, organisational, and inter-organisational learning as four levels of learning in the organisation that affect knowledge transfer. Many researchers consider new learning to originate in individuals (Argyris and Schon, 1996; Kim, 1993; Simon, 1991). Although learning is individual, it occurs in an organisation as a collective behaviour and is considered by many scholars to be a social process (e.g. Bawden and Zuber-Skerritt, 2002; Englehardt and Simmons, 2002; Gerber, 1998; Robinson et al., 1997; Simon, 1991; Tucker et al., 2002). Team thus serve as a learning forum for individuals. This forum provides an opportunity for dialogue to take place, which is described as a process of enquiry and advocacy (Senge, 1990). Hall (2001, p. 19) puts it succinctly by stating: “Knowledge creates knowledge only when it is shared”. Organisational learning will take place when new knowledge has been transferred and instituted into the wider organisation (Crossan et al., 1999). Since new knowledge may alter the beliefs and assumptions of the organisation, the organisation’s worldview (referred to as “Weltanschauung” by Kim, 1993) changes. This reflects on the changes of the organisation’s dominant routines, procedures and systems.

Inter-organisational learning is the fourth level of learning. In one organisation, it is difficult or impossible to develop all the required competencies under the rapid change of the external environment (Hatten and Rosenthal, 2001). Currently, most organisations retain core competencies and sustain competitive advantages through strategic alliances with other organisations. This necessitates the transfer of information between organisations, which is usually explicit procedural information.

Shi (1998) and Awny (2005) consider that developing countries as transferee hope to promote their own technology capabilities through ITT in order to cope with aggressive worldwide competition. However, indigenous technology capability of the transferee is a vital factor affecting success of ITT. UNCTC (United Nations Centre on Transnational Corporations, 1987, p.34) points out that "successful technology transfer should result in the development of recipients' technology capability in the acquisition, assimilation, operation, modification, improvement and replication of foreign technology with domestic resources and the subsequent independent development of new technology". Zhao Tiecui (Minister, China State Administration of Coal Mine Safety, 2010) also points out that Chinese coal enterprises need to learn the transferred knowledge sufficiently in the process of ITT.

Zhou and Sun (2005) argue that for recipients, there are two main stages to which they should pay more attention in the process of ITT, including the acquisition and absorption of technology. Technology acquisition refers to the external integration process, whereas technology absorption refers to the internal learning process. Technology acquisition, as the precondition of technology absorption, should be considered preferentially. According to the research findings of Madu (1989), Lai and Tsai (2009), Odigie (2012) and Megantz (2002), this study argues that government and technology management are two main dimensions that affect the acquisition and absorption of technology. Based on the study by Sun and Scott (2005), this study also argues for individual learning, team learning, organisational learning and inter-organisational learning as the four main dimensions that affect the absorption of technology. The following sections elaborate on the various aspects of six dimensions that affect effectiveness of ITT respectively.

Government

Since most Chinese coal mines are state-owned and are managed by the State-owned Assets

Supervision and Administration Commission, this means the government plays the role of a boss which controls all business operations of the state-owned coal mines. All policies and law have been legislated by the government. The government should be considered as the main dimension that affects the effectiveness of ITT in the Chinese coal mining industry. Madu (1989) considers that the political system of the recipient country works as the main factor that affects the effectiveness of ITT. Lai and Tsai (2009) argue that the government should make appropriate policies and regulations to safeguard organisations engaging in ITT. Odigie (2012) studies the ITT of Nigerian indigenous construction organisations. His research reveals that the effect of ITT will be affected by relevant policies through which the government encourages enterprises to innovate, invest in R&D and cooperate with research institutes.

Sun (2011) discovers a strange phenomenon in China in which a number of provincial governments have not investigated the real context of state-owned coal mines before making relevant policies. Additionally, they also have not sufficiently considered coal mines' advice and feedback. The original intention of many polices is to encourage coal mines to innovate through ITT, but it is difficult to achieve the government's expected result. The unrealistic policies are only based on governmental profit, and the policies have been made easy but implemented in a difficult manner. In addition, a number of policies have limited coal mines in selecting appropriate technology that fit them best.

Moreover, He and Si (2010) find that most Chinese enterprises are not good at ITT. They mainly depend on agencies when engaging in ITT, but the service quality of many agencies is low, because usually agencies lack professional staff including technicians, marketing experts and legal experts. This is due to Chinese agencies development policies and the current educational system. The development policies of Chinese TT agencies focus only on development of agency numbers rather than promotion of service quality, and the current educational system has been affected by historical reasons (see section 2.9).

Furthermore, Kirkland (1999) suggests that the protection level of intellectual property rights (IPR) is also a main factor that affects the effectiveness of ITT. Mao (2012) considers that current Chinese IPR protection is weak, which the entire country has only about two thousand professionals who possess professional qualifications and specialise in IPR protection. This is owing to the fact that the government has not enacted relevant policy to improve the current education system in order to train more relevant specialists to protect IPR. Based on the above information, the researcher argues that the government essentially plays a negative role in the ITT of the Chinese coal mining industry.

Technology Management in Organisations

Lin (2003) considers that enterprises in developing countries with limited technology and limited R&D resources are able to rely on ITT to improve their technological capability in order to obtain competitive advantages. Lihua (2008) argues that competitive advantages of an enterprise can be achieved through successful technology management. Madu (1989) points out that management can be a main factor affecting ITT. Megantz (2002) argues that technology management is a vital dimension that affects the effectiveness of ITT. Gregory (1995) considers that the process of technology management is comprised of the following five generic steps:

- Identification of technologies which may be of importance to business in the future
- Selection of technologies, which the enterprise needs for its future, by expert judgment

and financial support.

- Acquisition of selected technologies by licensing and purchasing equipment, etc.
- Exploitation of technologies that have been learned and assimilated in order to incorporate them into product development and technology innovation of the transferee
- Protection of technology assets by legal means.

Gregory's ISAEP technology management framework is also related to other models of technology management. For example, Sumanth and Sumanth (1996) consider that the process of technology management is comprised of awareness, acquisition, adaptation, advancement and abandonment. In addition, Jolly (1997) also proposes that a process framework of technology management consists of imagining, incubating, demonstrating, promoting and sustaining. Gregory's framework encompasses all technology management activities of an organisation. Therefore, this study adopts Gregory's framework to analyse the process of technology management.

According to Gregory's framework, the first step in technology management is to identify technologies which may be of importance to the business in the future. It is necessity to set up a special department to identify technology and be further responsible for ITT (Debackere and Veugelers, 2005; Macho-Stadler et al., 2007). The department is able to represent the organisation to contact potential transferors or other organisations in order to identify and select suitable technologies. Meanwhile, the department also coordinates with different departments in order to understand their technology requirements. The department's staff should possess rich relevant knowledge and ITT experience in order to deal professionally with many problems as they appear in the process of selection and transfer of technology. However, Wang (2010) considers that the management hierarchy of China's state-owned coal mines is different to that of many other countries. The status of the special department in China's coal enterprise is relatively low. Compared with other departments, the special department does not have the same status and power. In other words, the department is only an office and has two or three staff, which means that other departments may not pay enough attention to the special department. Since ITT is a complex process and requires many departments to cooperate together, it is difficult to achieve good results when other departments do not pay attention to and insufficiently support the special department in the process of ITT. This study argues that top managers should give powers and sufficient support to the special department; at the same time, top leaders should give the special department fair status and equitable treatment in order to coordinate and cooperate with other departments in the process of identifying and transferring technologies.

The second step is the selection of technologies through expert judgment and financial support. Chinese coal enterprises always hire professionals, external experts and agencies to select technology (Zhao, 2010). Nevertheless, He and Si (2010) argue that many of China's coal enterprises and technology transfer agencies lack professional staff and experts who possess rich experience and relevant know-how. This study argues that the situation can be attributed to the fact that the current education system cannot provide sufficient talented individual to the Chinese coal mining industry. Most coal enterprises have to rely on these unqualified staff and agencies.

The third step is the acquisition of the selected technologies by licensing and purchasing equipment. This involves channels of ITT that will be reviewed in the next section (section 2.8).

The fourth step is the exploiting of technologies that will be learned and assimilated in order to incorporate into product development and technology innovation of the transferees. Madu (1989) considers that enterprises should provide relevant training to staff in order to help them learn and assimilate the transferred knowledge. Liao et al (2006) consider that an enterprise should build the atmosphere of learning and sharing new knowledge, which is a vital factor to affect the acquisition of knowledge. In addition, systems and channels of communication between transferors and transferees as a main factor affect the assimilation of transferred technology (Kirkland, 1999; Lai and Tsai, 2009; Jasinski, 2009). Good communication systems and discussion forums need a number of 'gatekeepers' who are not only able to assimilate transferred knowledge, but also able to transform external knowledge into transferees' internal knowledge that staff can understand by gatekeepers sharing (Owens, 2012). Moreover, Lihua and Xie (2008) consider that innovation-based ITT can bring financial benefit to transferees, but the most important significance of technological innovation is to create social benefits and job opportunities as well as to increase economic benefits. Odigie (2012) has studied ITT in Nigerian indigenous construction organisations; he regards the technological innovation strategy of the recipient as the main factor that affects effectiveness of ITT.

The fifth step is the protection of technology assets by legal means. Kirkland (1999) argues that the protection level of IPR can be a main factor that affects the effectiveness of ITT.

Individual Learning

Lin (2003) considers that successful enterprises are those that can accumulate technological capabilities through learning after ITT. Remedios and Boreham (2004) discover that employees are motivated to engage in learning-related activities for various reasons. Bigge and Hunt (1980) identify the importance of individual willingness to learn. They further retain the differences between intrinsic, extrinsic, and interactive motivations for learning. While intrinsic motives are largely inner, extrinsic motives dwell in the outer environment of individuals. The interactive motives to learning are connected to both the inner willingness to learn and the outer environment. In fact, motivations to learn are more interactive than purely intrinsic or extrinsic. Achievement motivation as a concept is useful in understanding why human beings learn. Some motives can drive individuals to want to compete, attain a challenging target or goal, make a unique contribution to the organisation, solve a complex problem, carry out a challenging assignment successfully, or simply develop better ways of doing things (Wexley and Yukl, 1984). According to McClelland's achievement motivation theory, people are motivated to cope with difficulties because of their willingness to solve problems, willingness to attain power or have power, and willingness to build positive intimate relationships with others (Champoux, 1996; Nelson and Quick, 2003).

Cao (2005) considers that improvement of learning effect requires motivation of individual learning enthusiasm, rather than limit them under specific objectives. Enterprises should change the management style from "want staff to learn" to "staff want to learn". In addition, the development of the reward system is able to encourage individual learning and to improve the effect of ITT (Campbell, 2007; Ganguli et al., 2009), but Pink (2009) argues that many researchers consider "carrot-and-stick" or the reward and punishment approach as an effective way to motivate individual learning, which is a mistake. The reward and punishment style motivates staff when they face a simple task. It may not be an effective way when staff face a complex work task. Learning transferred knowledge is a complex process; therefore, a single reward system may not improve the learning effect.

Moreover, sharing learned knowledge with team members is important when the transferred knowledge has been learned by an individual; as Hall (2001, p. 19) argues "knowledge creates knowledge only when it is shared". This means that sufficient sharing of learned knowledge facilitates good learning outcomes. However, Mair (2004) points out that the individual is not willing to share learned know-how with team members in the context of fierce competition, unless there is a strong incentive. Lai and Tsai (2009) consider individual knowledge and the educational situation as important factors that affect the learning result. In other words, transferred technology needs individuals to have qualified capability to learn and to assimilate.

Team Learning

Johnson et al (2000) consider that teams succeed when they are linked to the organisation's strategies, whilst individuals in the team may do what they feel is right and are not afraid of taking any risks.

Castka et al (2003) in their assessment of factors that affect the successful implementation of high performing teams note the following elements as factors that influence team effectiveness: rewards, measures of performance, knowledge and skills of individual members and the team as a whole.

Sun and Scott (2005) consider that the following factors have an effect on individuals in team learning:

- Openness to ideas
- An learning environment
- Fear that knowledge may be inadequate or unimpressive

- Learning aptitude of the individual
- Need to gain acceptance into the group

Liao (2006) considers that knowledge-sharing behaviour plays an important role in organisational learning, especially in team learning. Power also influences learning in a team. Managers' behaviour negatively affects the learning effect when they inappropriately use power in learning activities. In analysing the influence of power and politics in organisational learning, Lawrence et al (2005) argue that the two elements fuel the learning process and need to be cultivated and remedied. Similarly, Blackler and McDonald (2000) also analyse the influence of power in an organisation's learning processes and discover that while power does play a vital role, there is still a need to understand the role of power in organisation's learning. Edmondson (2002) adopts a group-level perspective on organisation's learning and discovers that power does influence how groups and teams learn in an organisation.

Organisational Learning

Zhang (2009) considers that the learning effect of transferred knowledge is affected by the transferee's original knowledge background, which involves a dynamic and integrated experience system which includes a variety of knowledge. Zhou and Sun (2005) further consider that the organisational knowledge background is a conceptual ecology which affects the learning of the transferred knowledge. In addition, the intensity of organisational investing and R&D technology affects the effectiveness of ITT (Madu, 1989; Lai and Tsai, 2009).

Sun and Scott (2005) considers that the following two factors influence organisational learning:

- Team conforming with organisational assumptions and beliefs
- Organisational learning aptitude of enterprise

Albert (2005) claims that the top management support and the involvement of the consultant also facilitate organisational learning and change. Lohman (2005) finds the factors of initiative, positive personality traits, the commitment to professional development, the interests in the profession and the love of learning enhanced the motivation for informal organisational learning.

Chang (2005) argues that the effectiveness of organisational learning is not equal to the sum of individual learning effectiveness. It might be higher or lower than the sum of individual learning effectiveness, mainly depending on the degree of sharing of know-how.

Inter-organisational Learning

Larsson et al (1998) consider that inter-organisational learning is the collective acquisition of knowledge among a group of organisations. This knowledge acquisition can be achieved by complementing and transferring each other's knowledge and by creating new knowledge. In particular, through inter-organisational learning, firms can speed up their capability development and minimize their exposure to technological uncertainties by acquiring and exploiting knowledge developed by others (Lane and Lubatkin, 1998). Learning in networks is thus the ability to identify, assimilate and utilise partners' knowledge.

Sun and Scott (2005) consider that the management direction of the enterprise is a vital factor impacting on inter-organisational learning, because top managers have power and are able to encourage or stifle inter-organisational learning in an organisation. Jian et al (2010) further considers that the organisation learns from other partner organisations, by sharing knowledge with them, gaining their trust and support, which are important factors influencing the effect of ITT.

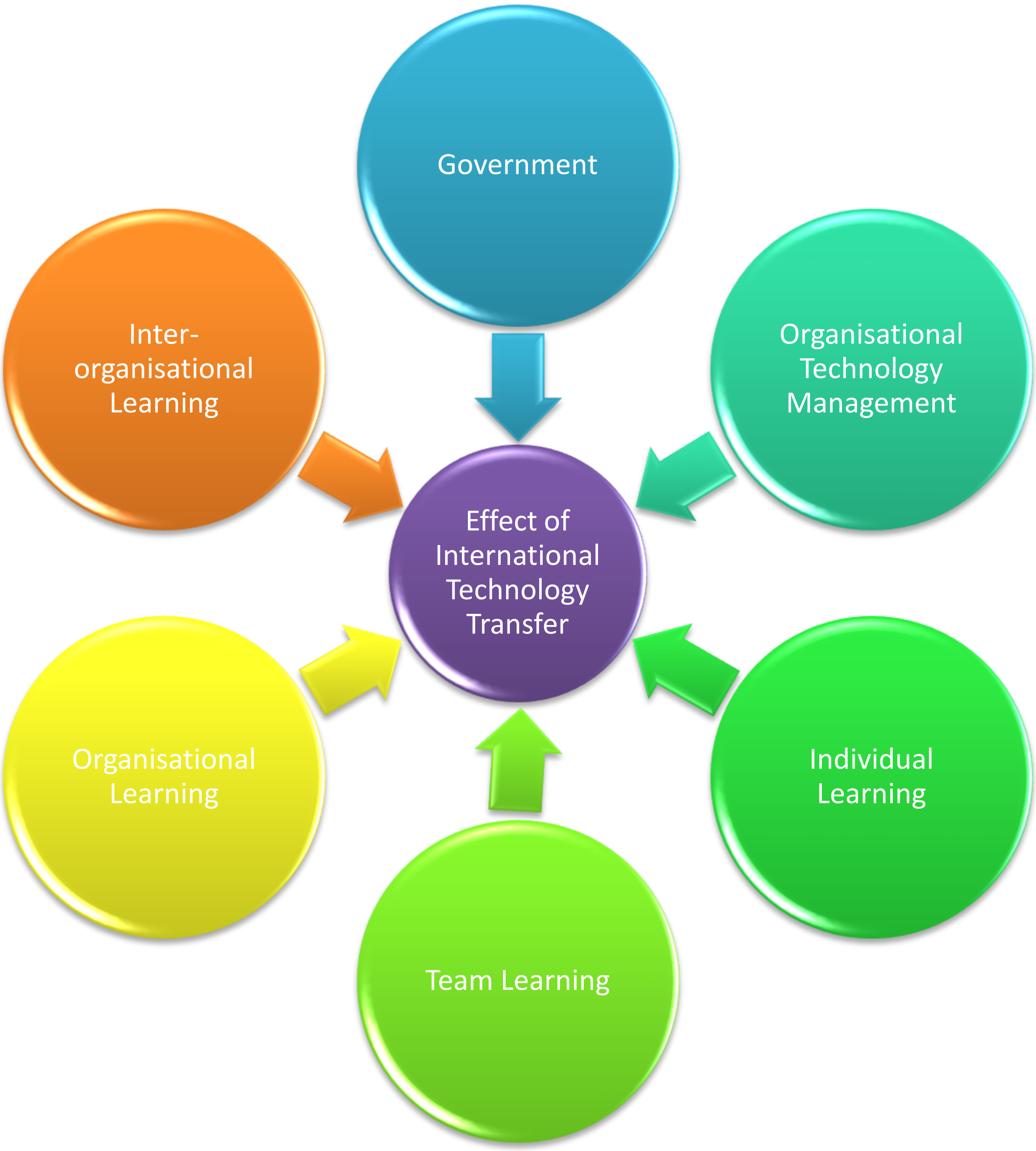


Figure 2.5 Theoretical framework: dimensions affecting effectiveness of ITT

Based on extant theories, this study developed a theoretical framework consisting of six main dimensions (see Figure 2.5), but the validity and reliability of the theoretical framework needs to be further demonstrated through comparing the existing theories with empirical findings in order to determine which theories are suitable for studying the Chinese coal mining industry. In addition, this study hypothesizes that there are relationships between ITT effectiveness and the six dimensions. In order to test the relationships, hypotheses were developed based on the theoretical framework which made the complex process of ITT comprehensible and transparent to researchers and decision-makers of coal enterprises. However, although there might be other dimensions that have been underlined in the extant literature affecting the effectiveness of ITT, in this study, the six dimensions are the most salient factors that influence the effect of ITT in the Chinese coal mining industry. Therefore, the following hypotheses have been developed.

- The relationship between ITT effect and government

H1. Government has a positive correlation with effectiveness of ITT.

- The relationship between ITT effect and technology management

H2. Technology management has a positive correlation with effectiveness of ITT.

- The relationship between ITT effect and multiple levels of learning in organisations

H3. Individual learning has a positive correlation with effectiveness of ITT

H4. Team learning has a positive correlation with effectiveness of ITT

H5. Organisational learning has a positive correlation with effectiveness of ITT

H6. Inter-organisational learning has a positive correlation with effectiveness of ITT

2.8 Chinese Coal Mining Industry

According to the report of the China Coal Industry Association in 2013, China achieved the largest coal production (3,878Mt) and consumption (3,917Mt) in the world in 2011. About 49.6 per cent of current energy consumption in China was covered by coal in 2011, and future energy use is also expected to rely heavily on coal (BP Statistical Review of World Energy, 2012). The BP Statistical Review of World Energy (2011) showed that China's coal production and consumption accounted for 48.3% and 48.2% of the world's production and consumption in 2010. The coal mining industry is certainly a dominant industry in China. The development and modernization of the coal mining industry remain a top priority on the national agenda. Figure 2.6 and Table 2.1 present Chinese coal production and consumption from 1949 to 2011.

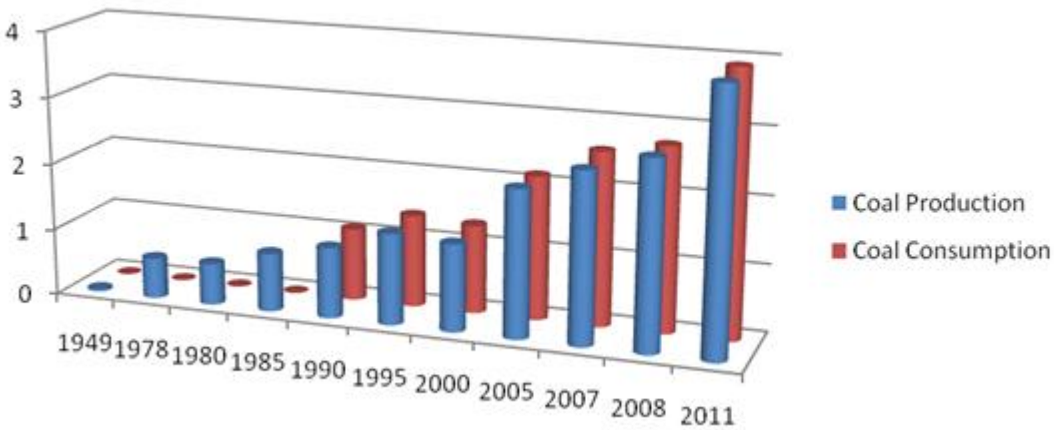


Figure 2.6 Chinese coal productions and consumption from 1949 to 2011

Source: Report of China National Coal Association 2012

Year	Coal Production	Coal Consumption
1949	32 Mt	N/A
1978	607 Mt	N/A
1980	620 Mt	N/A
1985	872 Mt	N/A
1990	1,055 Mt	1,080 Mt
1995	1,360 Mt	1,377 Mt

2000	1,299 Mt	1,320 Mt
2005	2,190 Mt	2,140 Mt
2007	2,536 Mt	2,580 Mt
2008	2,790 Mt	2,740 Mt
2011	3,878 Mt	3,917 Mt

Table 2.1 Chinese coal production and consumption from 1949 to 2011

Source: Report of China National Coal Association 2012

From 2000 to 2010, average prices of coal kept on increasing, rising from 246 RMB/Tonne (Xinhua, 2005) to 618 RMB/Tonne (Sina, 2013). The great profit to be made attracted a lot of new investors to this market. In China, the ample coal reserves are widely distributed throughout the country, but the uneven geological conditions lead to coal reserves and coal mining intensity in the western region being higher than the eastern region. In addition, coal exploration and excavating in China is very complicated; most of coal resources are deposited in deeper coal seams rather than surface shallow coal seams. Mining of deeper coal seams in the large state-owned coal mines relies on mechanization. However, a number of local state-owned coal mines excavate deeper coal seams by partial mechanization and many small coal mines, often in villages, still rely on manual mining through cheap labour, which drops productivity of coal mining and increases mining risks.

According to data from the China State Administration of Coal Mine Safety (2012), the Chinese coal mining industry killed more than six miners due to fatalities every day in 2010, which accounts for about 70 percent of the world's coal mining casualties. The main cause of fatality is gas explosions. Total deaths in the Chinese coal mining industry were 2,433 in 2010; 593 deaths were caused by gas explosions, which accounts for 24.3% of total (State

Administration of Work Safety, 2011). Moreover, 50% of state-owned coal mines have gas outburst and high gas. The gas problem has already become the biggest safety challenge faced by the Chinese coal mining industry.

Methane is also known as CH4 and its main component is natural gas, which is stored in the coal seam and released in the process of coal mining. When CH4 takes up between 5 percent and 16 percent of the air, and meets fire, an explosion will occur. In addition, the Chinese coal mining industry releases 10 billion cubic metres of methane every year, which accounts for one-third of the methane released by coal mining globally. Emissions will continue to increase with rising production. China's emissions will jump to 45 percent in 2020 if China does not take measures to control its methane emissions (Hexun, 2011). Furthermore, methane has strong greenhouse effect, and its greenhouse effect is 20 times higher than carbon dioxide when it is released into the air, also its ability to damage the ozonosphere is 10 times higher than carbon dioxide. Most Chinese coal enterprises release methane directly into the air. Environmental problems have also been regarded as the main challenge that Chinese coal mining industry is facing.

The former Chinese Premier, Wen Jiabao, a former mining engineer, (2005) points out that the fundamental reason for causing such frequent accidents is the lack of technology and equipment in controlling and utilizing methane. The latest technologies of coal-bed methane (CBM) drainage can effectively solve these problems. The technology can drain methane by drilling and extracting gas from the coal bed before mining, reducing methane content in the coal bed. This can improve mine safety and reduce methane emissions.

Li et al (2009) points out that there are two main factors that affect the effect of coal-bed methane (CBM) drainage:

- Permeability of the coal seam
- Parameters of drilling drainage

The improvement of permeability of the coal seam is a worldwide problem, and researchers have failed to solve the problem despite years of research.

Parameters of drilling drainage include many aspects, such as density of drilling, distribution of drilling, depth of drilling, diameter of drilling, negative pressure of drainage, etc. The technology of drilling rigs has already achieved significant development by foreign enterprise through years of research. Currently, American and Australian drilling technology is very advanced across the world. Five coal enterprises (Tiefa, Huainan, Songzao, Pingdingshan and Fushun) in five Chinese provinces have tried to transfer the technology of 1000m drilling from the Australia Valley Company through various of ITT channel in 2003. Chinese enterprises hope to drill down 1000 metres using the technology, but currently they have only achieved 300 metres in China, despite the same technology drilling down 1000 metres in Australia (Liu, 2008).

There are two main reasons why the technology has not been transferred successfully. First of all, the recipient has not sufficiently learned and assimilated the transferred technology, and this led to inappropriate operating of the transferred technology by the recipient’s technicians, which affects drilling depth (Liu, 2008).

Second, actual drilling capacity of the technology depends on the geological conditions of the coal seam. Owing to different geological conditions, specifically the different hardness of the coal seam, before choosing transferred technology, the technicians and engineers of recipient should understand local geological conditions, the technology capability and the characteristics of the transferred technology in order to select suitable technology, but the recipients lack professional technicians and engineers to evaluate these aspects (Liu, 2008).

Why does the Chinese coal mining industry lack professional technicians and engineers? This can be attributed to historical reasons. China carried out reforms and a policy of opening up after 1980, which made the development of various industries more active. Social and economic increases in coal demand, couples with shortage of coal supply as a constraint factor affected the development of the national economy. In response to this situation, the government relaxed the policy on the management of the coal mining industry, which accelerated the development of state-owned coal mines; at the same time, it also encouraged the development of small town and village coal mines. The State Council promulgated <Speed up the Development of Township Coal Mines on the Eight Measures> in April 1983. The document proposed that the coal mining industry should positively develop local state-owned coal mines and small town and village mines. The government also proposed a new policy to encourage state, collectives and individuals to develop large, medium and small coal mines together in 1984 and 1985. This led to the result that the amount of coal mines increased rapidly, but the industrial concentration was very low. At the end of 1997, China's total quantities of coal mines reached 64,000, but 61,000 mines were small coal mines and accounted for nearly 94% of the total amount.

Chinese coal production rapidly increased through the encouragement policy, but the quality of coal was very poor; low industrial concentration caused poor information transmission of supplier and customer; it also caused an overly competitive coal market and disordered market price. The coal market appears to be oversupplied in 1996; operation of large state-owned coal mines had already become very difficult in a chaotic market. The government was aware of the fact that sluggish coal sales and rising inventories had led the entire industry into its unprecedented temporary difficulties. In order to overcome the problem of coal production and sales, coal enterprises had to cut staff to cut costs, and demand for professionals was declining at that stage. In addition, a poor working environment and low wages led professionals and technicians to flow to other industries. Moreover, the Ministry of Coal was revoked in 1998, top management authority of the coal industry decentralized to the seven Ministries. Just as security belongs to the State Administration of Work Safety Supervision, education and scientific research belongs to the Ministry of Education, Science and Technology belongs to the Ministry of Science and Technology, business management belongs to the Ministry of Commerce. In addition, the Ministry of Coal used to own 15 mining universities; but fourteen of them have changed their names and adjusted their research direction to service the local economy and other industries, with the exception of the China University of Mining Technology (Liu, 2008).

The following fourteen universities changed their names and adjusted their research direction (Liu, 2008):

1. Fuxin Mining Institute changed its name to Liaoning Technical University in April 1996.
2. Shandong Institute of Mining and Technology changed its name to Shandong University of Science and Technology in 1999.
3. Xi’an Mining Institute changed its name to Xi’an College of Science and Technology in June 1999. It changed its name to Xi’an University of Science and Technology in April 2003.
4. Jiaozuo Mining Institute changed its name to Henan Polytechnic University in May 2004.
5. Shanxi Institute of Mining merged with Taiyuan Polytechnic University to change its name to Taiyuan University of Technology in 1997.

6. Huainan Mining Institute changed its name to Anhui University of Science and Technology in 2002.

7. North China Coal Medical University merged with Hebei Polytechnic University changed its name to Hebei United University in May 2010.

8. Hebei Institute of Coal Mining and Civil Engineering changed its name to Hebei Institute of Architectural Science and Technology in 1996.

9. China Coal Economic College changed its name to Shandong Institute of Business and Technology in February 2003.

10. Xiangtan Mining Institute changed its name to Xiangtan Institute of Technology in 1997; Xiangtan Institute of Technology merged with Xiangtan Normal University to become Hunan University of Science and Technology in 2003.

11. Heilongjiang Mining Institute changed its name to Heilongjiang Institute of Science and Technology in 2000.

12. Huaibei Coal Industry Teachers College changed its name to Huaibei Normal University in March 2010.

13. Jixi Coal Medicine Higher Training School merged with Harbin Medical University in 2002.

14. Beijing Coal Industry School changed its name to Beijing Polytechnic College in 1999.

Why did these universities remove the word ‘coal’ from their names? Because the Chinese coal market was in recession from 1996 to 2003, the poor employment environment led to most of the graduates was not hired in this stage. This also led most students to apply for other disciplines rather than coal mining. The Ministry of Education links the employment rate of university graduates with the development of the university since 2003; courses would be cancelled in the university if the discipline has low admission and employment rates. Short supply of students led to the fact that many disciplines in mining universities were cancelled; cancellation of disciplines affected universities' reputation and reduced research funding. Many universities hoped to change their name and direction of research in order to attract more students. However, the coal mining industry has given the student an impression of working under poor environmental conditions and high risks. Furthermore, coal mining engineering has been selected by students as one of the most horrible ten disciplines in Chinese universities. These factors led to the fact that the coal mining industry lacks professionals and encounters a huge loss of talented individual. Mr. Yizhong Li (Director General, State Administration of Work Safety, 2005) considers that the industry will face extinction if it cannot attract more graduates.

The coal mining industry began a gradual recovery by driving of the country's overall economy since 2003. Under this climate, the market requirement for coal has expanded rapidly. The coal supply rose from 1.6 billion tons in 2003 to 3.2 billion tons in 2010, but it still could not satisfy the needs of society, and therefore China imported 160 million tons coal in 2010.

The current situation of the Chinese coal mining industry can be summed up in a sentence "the best coal mine is in China and the worst coal mine is also in China" (Wen, 2006). The former Chinese Premier Wen Jiabao said this in 2006 when he visited Shendong mine district of the Shenhua Group, which is located in Inner Mongolia – the district has the biggest coal base in the world. The mine district has broken nine coal mining world records. Its production efficiency is the highest in the world, a mine produces 124 tons coal per year, compared to 41.73 tons in America, three times higher. Its production from a single mine is No.1 in the world, the Enlow Fork mine of American Consol Energy Group is the previous

No.1 and its production is 9.71 million tons per year; Shendong has two 20 million ton mines and six 10 million ton mines, it also retains No.1 position in building speed and drilling footage. Deaths per million tons are lower than the United States and Australia. According to Shendong's statistics in 2007, Shendong have invested 21.6 billion RMB (about 2.1 billion pounds Sterling) in construction of the mine district between 1996 and 2006, including 13.3 billion RMB (1.3 billion pounds Sterling) which is the fee of transfer advanced technology and accounts for 61.7% of the total. However, the worst coal mine in the world is also located in Guizhou Province of China, which is a small coal mine in a village and has only two pieces of equipment: a miner's lamp and a pickaxe. Miners still depend on explosives to mine coal.

Currently, China's government is breaking the technology gap between state-owned coal mines and small private coal mines through instituting a series of policies. For example, the government is engaged in the merger of state-owned and private coal enterprises. According to the national mandatory policies (2010), state-owned coal enterprises have to merge with small private coal mines to form new coal mines; this forces state-owned coal mines to improve the technology level of small coal mines after merging.

Wang (2010) considers that the national enforcement merger policy is blind and unreasonable. First of all, small coal mines commonly have complex geological conditions and thin coal seams, and this leads to higher mining costs, while state-owned coal mines always abandon mine of the source. Secondly, thin coal seams and complex geological conditions lead to the fact that it is difficult to use mechanized mining in small coal mines; this means that small coal mines will become a burden for state-owned coal mines after merging. Thirdly, large state-owned coal mines are unwilling to merge with small coal mines, because small coal mines are same as a time bomb for managers of state-owned coal mines. Once small coal mines have any accident after merge, managers of state-owned coal mine will be deposed. In addition, merger will lead to increase of mining costs and reduction of R&D funding in state-owned coal mines. Therefore, the government should enact relevant policies based on enterprises' interest in order to avoid the situation that policies have been made easily but are difficult to implement.

Wang (2010) also argues that the Chinese coal mining industry can be concluded as "big but not strong" lacking core technologies, and the technological level will still stay at a low-level of duplication and imitation. China has the most advanced mines, but the mine has half the technologies of foreign countries. The Chinese coal mining industry has learned a number of lessons after assimilating transferred technology, but the key and core technology still depends on foreign enterprises.

2.9 ITT in the Chinese Coal Mining Industry

The ITT development of Chinese coal mining industry can be divided into 6 phases (Wang, 2010).

The first phase (1949 – 1959)

New China was established in 1949. At that time, the technology system of the Chinese coal mining industry was in a mess; the coal mining industry had almost no advanced technology, and all mines were mining manually. In China's first five-year plan (1953-1957), owing to the USA and UK adopting a policy of blockade and embargo, China had to importe a large number of complete sets of technology and equipment from the former Soviet Union and

Eastern Europe; these technologies helped China achieve rapid industrialization in the early years of new China's foundation.

The phase had some specific characteristics: (1) the transferred technology was mainly from socialist countries; (2) the channel of ITT was only to import equipment and technical assistance; (3) from 1949 to now, the efficiency of ITT at this stage was the highest, because the government combined all the resources and encouraged people's enthusiasm for building a new China.

The second phase (1959 – 1962)

China experienced three years of serious natural disasters during this phase, while the Soviet Union unilaterally tore up the agreement and withdrew a large number of experts, suspended economic and technological cooperation with China. Many Eastern European socialist countries feared to offend the Soviet Union and also stopped cooperating with China, therefore China had to independently research and develop new technology.

Some characteristics of this stage include: (1) technology transfer mainly restricted to domestic technology diffusion, and utilised technologies obtained in the first phase to develope new technologies, (2) assimilate foreign technology to make them more localized, (3) during this period, ITT has been almost entirely interrupted.

The third phase (1962 – 1978)

China's coal mining industry began to import technology from western developed countries, because the United Nations restored China's legitimate seat in October 1971, and China established foreign relations with the USA, Canada, Australia and other developed countries.

Western developed countries suspended the policy of isolation and blockade; the gate of official economic and technological cooperation had been opened. In this period, Japan, UK, France, Germany, Austria and the Netherlands had transferred key technologies and equipment to the Chinese coal mining industry. However, the Cultural Revolution (from 1966 to 1976) weakened the intensity of ITT.

This phase has some specific characteristics: (1) the source of ITT was expanded to Europe and Japan, (2) the channel of ITT changed from importing technology and equipment to licensing, (3) ITT of the phase had some blindness, because China's technology base was very weak, there were some problems in maintenance and utilisation of the transferred technology, the government could not coordinate the relationship between the transferred technologies and domestic resources effectively, therefore ITT of this period encountered some problems.

The fourth phase (1978 – 1989)

The Third Plenary Session of the 11th Central Committee of the CPC (Communist Party of China) established the policy of reform and opening up. China opened up a special economic zone and coastal cities in order to utilise FDI and facilitate ITT. Economic reform and opening up policies led to ITT displaying booming prospects; the coal mining industry imported a number of important production lines; these technologies and types of equipment effectively pushed on the development of China's coal mining industry, but it also exposed many problems, such as repeated transfer, paying no attention to transfer of soft technology and lack of technological transformation for localization.

Characteristics of the phrase included: (1) the source of ITT was extended to more regions, such as Hong Kong and Taiwan etc., (2) channels of ITT evolved into more flexible forms, such as licensing and joint venture, franchising, technical services, technical consulting, (3) central government decentralized some approval authority of ITT projects to local government to enhance the autonomy of local enterprises' ITT, (4) funding sources of ITT tended to diversification, such as government loans, domestic commercial bank loans, international financial organisations' loans, foreign technology exporters credit. In addition, there was no theoretical guidance of ITT in this stage, so it was also confusing period for researchers. A number of policies stimulated the enthusiasm of enterprises engaging in ITT; it also led to enterprises to repeatedly transfer the same technology and this caused much waste of resources; this stage was commonly known as the leap of ITT.

The fifth phase (1989 – 1992)

The June Fourth Incident of 1989 led to a technology blockade of developed countries to China, and therefore China had to rely on independent innovation to develop high-tech. The incident gave China's coal mining industry a breathing space to assimilate the previously obtained foreign technologies. In this period, the government also realized the importance of independent innovation; China was changing its method of development from depending on ITT to combining ITT with independent innovation.

Characteristics of the phase included: (1) more and more local enterprises had accumulated technological capability through ITT, and then transferred their independent R&D technologies to local other coal enterprises, (2) the establishment of the domestic capital market provided more financing for enterprises engaging in ITT, (3) large state-owned coal enterprises realized the importance of independent R&D and began to establish their own R&D centres.

The sixth phase (1992 – now)

After three years low and hovering, China began its reform in 1992 and the international situation has gradually improved during this period. Change of the international environment has given the coal mining industry more challenges and opportunities after China became a member of the World Trade Organisation. Many enterprises have spent more investment on ITT and R&D in order to acquire new technology and assimilate know-how. The government has begun to improve relevant policies and law in order to facilitate ITT. Licensing and inter-firm technology transfer has been frequently adopted in the coal mining industry in this stage. Technology absorption and innovation has been paid more attention by the top leaders of coal enterprises.

Characteristics of the phase have included: (1) an emphasis has been put on technology innovation rather than simple imitation, (2) an emphasis has been put on learning and assimilating transferred know-how through scientific technology management and multiple levels of learning in the organisation, (2) an emphasis has been put on the government as a vital dimension affecting the effectiveness of ITT.

2.10 ITT in the US Coal Mining Industry

Owing to the limited research on ITT in the Chinese coal mining industry, this study reviewed ITT of the American coal mining industry in order that the Chinese coal mining industry can understand what should be learned from the American experience.

There are three reasons why the US coal mining industry has been chosen. Firstly, the development history of the US coal mining industry is longer than China; it has more experience than China in ITT. Secondly, the US is the second largest coal producer in the world. According to preliminary data from the US Energy Information Administration (2012), coal production reached 1,094 million short tons in 2011. Figure 2.7 shows production of the US coal mining industry from 1890 to 2005.

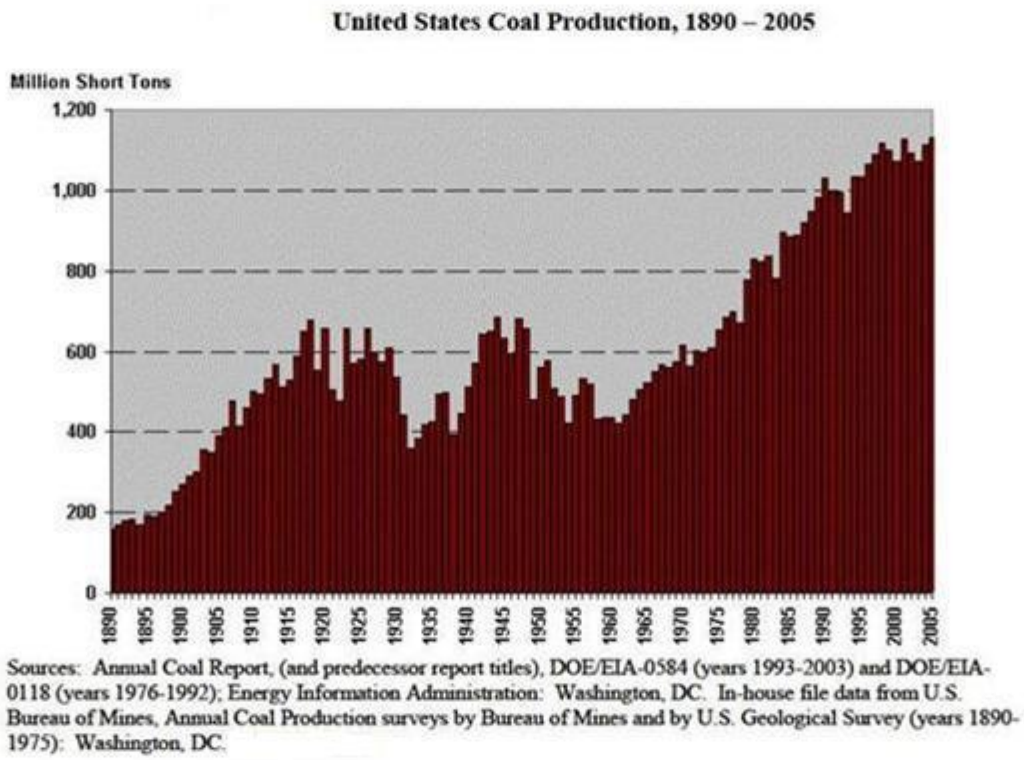
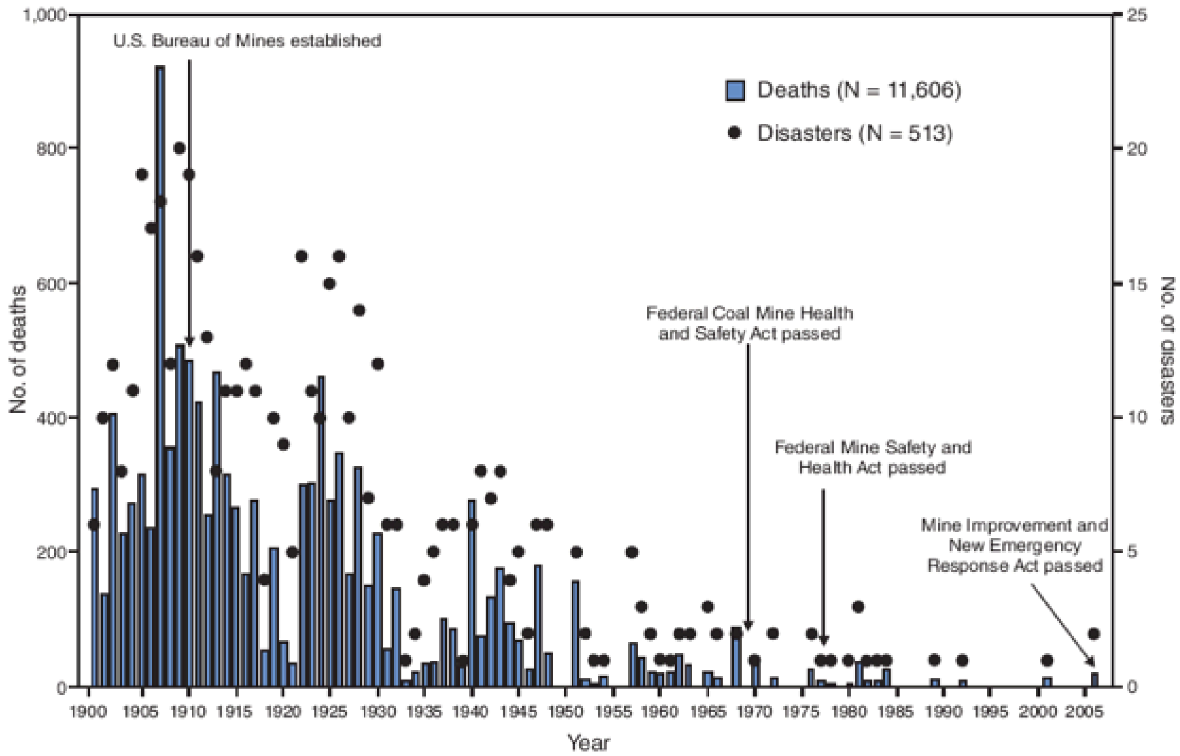


Figure 2.7 Production of the US coal mining industry from 1890 to 2005.

Source: Annual Coal Report, DOE/EIA-0584 (years 1993-2003) and DOE/EIA-0118 (years 1976-1992); Energy Information Administration: Washington, DC. In-house file data from U.S. Bureau of Mines, Annual Coal Production surveys by Bureau of Mines and by U.S. Geological Survey (years 1890-1975): Washington, DC.

Thirdly, the technology level of the US coal mining industry is higher than China. China used 4 million miners to produce 3,878 Mt in 2011, while the US used 88,000 miners to achieve production of 1,089 Mt. Data from the State Administration of Work Safety showed that there were 1,973 deaths in the coal mining industry in China in 2011, but in the US coal mining industry there were only 48 deaths. Figure 2.8 shows that mortality in the US coal mining industry declined from 1900 to 2006.

FIGURE. Number of worker deaths in underground coal mining disasters* and key mining safety milestones — United States, 1900–2006



* Disasters are defined by the Mine Safety and Health Administration as incidents resulting in five or more deaths.

Figure 2.8 Underground Coal Mining Disasters and Fatalities--United States, 1900—2006.

Source: CDC (2009)

Why is the productivity of the US coal mining industry higher than China yet mortality is lower? The US coal mining industry also suffered frequent accidents at the beginning of the 20th century, but the US government made great efforts to promote the technology level of the industry through enacting the following laws and policies for facilitating technology transfer and innovation over the past 30 years:

- Bayh Dole Act (1980)
- Stevenson-Wydler Technology Innovation Act (1980)
- Federal Technology Transfer Act (1986)
- National Competitiveness Technology Transfer Act (1989)

- National Technology Transfer and Advancement Act (1996)

These laws guaranteed and facilitated development of ITT in the US coal mining industry, but China had not had specific laws and regulations for technology transfer until the 'Nanjing City Promote Technology Transfer Regulation' was implemented on 1 April 2011, which was the first local regulation of technology transfer in China.

Furthermore, the US Constitution Article 1 Section 8 Clause 8 explicitly addressed an objective of the US to promote the progress of science and useful arts by securing exclusive rights in a limited time for authors and inventors to their respective writings and discoveries. The law effectively protected IPR of the transferor in ITT.

Comparing US with Chinese IPR protection, the weak IPR protection environment of China has already seriously affected the effectiveness of ITT. For example, transferors need to elaborate on know-how of transferred technology to engineers and technicians of the recipient in the process of ITT; if the IPR has not been sufficiently protected in the recipient country, the transferor will deliberately withhold know-how in order to prevent other competitors copying its technology by learning its patents (Branstetter et al., 2006). In addition, there is a risk that engineers and technicians of the transferee may defect to competitors, taking sensitive technology with them. If the IPR protection situation in the recipient country is weak, these defectors are able to combine the patented and unpatented know-how of the transferred technology to effectively compete with the transferee in the local market. Although the Chinese government enacted a number of relevant laws for protecting IPR, these laws have not been effectively and strictly implemented. Sometimes transferors cannot prevent transferees or other competitors infringing and using patented components of transferred technology in China.

Moreover, American laws and policies not only facilitate ITT, but also encourage technology innovation so it can prevent ITT falling into a vicious cycle that China's coal mining industry has become trapped in: "transfer — get behind — transfer again — get behind again". An industry should innovate and develop its core technology rather than relying on ITT. China's coal mining industry should understand that ITT is only a tool, and technology innovation is the final objective.

Pan and Huang (2008) compared Chinese with American ITT and summarized the following two aspects which China would do well to learn:

- The US government established a complete set of policies and a legal system of ITT through legislating. The system guaranteed implementation of relevant policies and guaranteed benefit of both transferor and transferee.
- The US government strengthened the service role in ITT, and weakened the distribution of benefit that the government obtained when it participated in ITT.

2.11 Conclusion

This chapter has reviewed a wide range of literature on technology, TT, ITT, transfer, learning and innovation of knowledge, China's coal mining industry, the comparison between ITT in the Chinese coal mining industry and that of the USA. In particular, great effort has been made to review literature on factors affecting the effectiveness of ITT. The review has developed the researcher's holistic understanding about the concept, process, opportunities, challenges and affecting factors of ITT in the Chinese coal mining industry.

In addition, the researcher has discovered that literature on ITT in the Chinese coal mining industry has not been well developed, and a number of important research questions remain unclear, such as how ITT is understood and defined in the coal mining industry in the Chinese context, how technology is transferred from developed countries to Chinese coal mining industry, and what factors affect the effectiveness of ITT in the coal mining industry. Although some studies did mention ITT in the coal mining industry, they generally failed to answer the above questions.

Combining the findings from literature on the understanding of technology transfer and knowledge transfer, the concept of technology transfer can be refined as the transfer of systematic knowledge. Based on this definition, this study argues that government, technology management, and multiple levels of learning within the organisation are the main dimensions affecting the effectiveness of ITT.

Moreover, Ounjian and Carne (1987) consider that the ITT channel is also a vital factor that affects the effectiveness of ITT. Therefore, the next chapter will review the main channels of ITT in China.

Chapter 3 – Channels and Mechanisms of ITT in China

3.1 Introduction

ITT can take place through a number of different channels (Jafarieh, 2001). The channel for ITT is the link between transferors and transferees for the exchange of information and knowledge. Al Ali (1995) thinks that the mechanism or channel of single ITT is not appropriate for all circumstances. The policy characteristics of supplier and recipient country, nature of transferred technology, transferor's desire and transferee's technology capacity will decide which mechanisms and channels of ITT are the most appropriate for both parties. The importance of the choice of ITT channels has made many developing countries examine various channels of technology acquisition in order to select the most suitable one (Jafarieh, 2001). This enables these countries to reduce the cost of ITT in order to assimilate the transferred technology more efficiently based on their local conditions (United Nations Centre on Transnational Corporations, 1987).

Ounjian and Carne (1987) consider that the factors that affect the effect of ITT include the characters of transferors, recipients, technology and communication channels. Lai and Tsai (2009) further point out the factors that affect the effect of ITT, contain the transferring channels, characteristics, interactions and communications. The objective of this study is to identify factors that affect the effect of ITT of the Chinese coal mining industry. Therefore, it is necessary to identify which channel of ITT has been most frequently adopted in the industry through literature review and empirical research in order to narrow down the analysis scope and to understand the current development situation of ITT in the Chinese coal mining industry.

UNCTAD (1987) reveals that the channels of ITT could be divided into the commercial and the non-commercial. The following list is the eleven forms of the commercial channel:

- Foreign direct investment
- Joint ventures
- Licensing Agreement
- Patents and Patent Agreements
- Know-how and the Know-how Agreement
- Trademark and Trademark Agreement
- Turnkey Contract
- Management Contract
- International Subcontracting
- Franchising Agreement
- Imports of Capital Goods and Machinery

The non-commercial channels include experts exchange and co-operative R&D. Generally, commercial transfer may generate more complicated issues than non-commercial in the process of transfer.

3.2 Channels and Mechanisms of ITT in China

Foreign Direct Investment

The Organisation for Economic Cooperation and Development (OECD, 1996) defines FDI is the objective of obtaining a lasting interest by a resident entity in one economy (direct investor) in an entity resident in an economy other than that of the investor (direct investment enterprise). The lasting interest implies the existence of a long-term relationship between the direct investor and the enterprise and a significant degree of influence on the management of the enterprise.

Baldwin et al (1999) point out that FDI is one of the most important ITT channels when multinational corporations (MNCs) transfer technologies to recipient countries. MNCs transfer their capital, equipment, patents, management experiences and technologies to overseas subsidiaries, which have usually been established in developing countries, such as China, where low-cost human resource and raw materials are located. Since MNCs adopt their technologies during investing in recipient countries, technological di ffusion will possibly promote the productivity of the recipient countries. Compared with the simple technology trade, FDI has a complete set of advantages. It is not just about mere transfer of technology, but also refers to the transfer of various know-how, managerial experiences and entrepreneurs' abilities.

According to UNCTAD's World Investment Report 2010, China was already the second biggest recipient country of FDI after the United States in 2008 (shown in Figure 3.1), China has attracted a large number of FDI in order to learn and gain their technologies, know-how and R&D capabilities. China has also promulgated a series of preferential policies in order to attract more FDI.

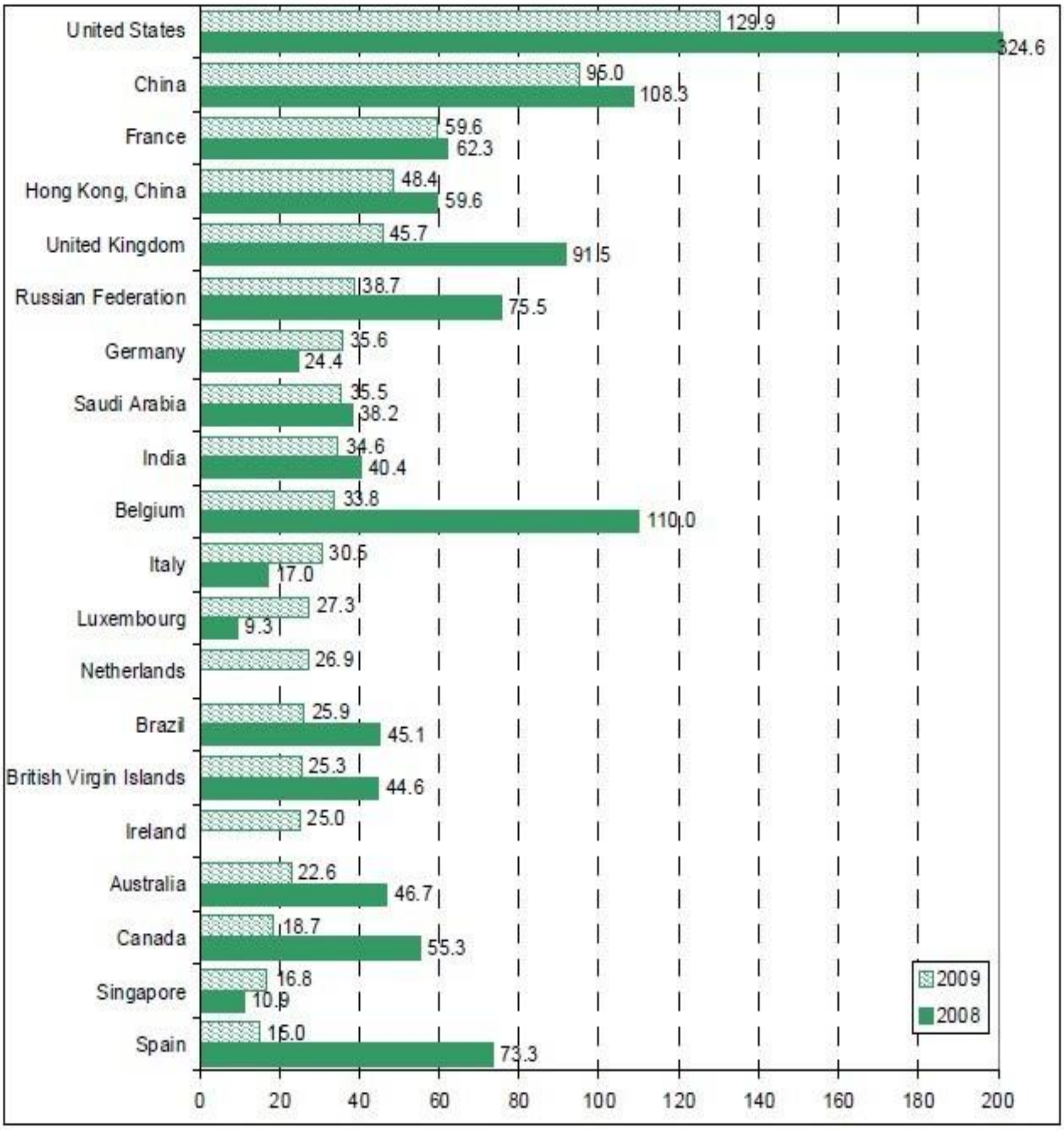


Figure 3.1 2008-2009 Top 20 host economies of FDI Inflow (Unit: Billions of Dollars)

Source: UNCTAD's World Investment Report 2010, p.4

Lewis (2004) argues that rising Chinese labour costs would lead to the disappearance of the "unlimited labour supply". For instance, FDI flow to China in 2009 plummeted to 95 billion dollars, with a 13.3 billion dollars decline compared to the historic high of 108.3 billion dollars in 2008 (Figure 3.1). Jia (2010) further analyses the reasons of foreign direct investment declining in China and reveals the liquidity problem of international investors after the subprime crisis. He points out that increasing labour costs will lead to investors disinvesting from China in the next few years, and investors preferring to invest in countries with lower wage costs, such as Vietnam.

MNCs usually monopolise core technology and transfer non-core technology to the subsidiaries in China, so Chinese enterprises have only learned non-core technology through technological spillover. This leads to technological dependence and less innovation in Chinese enterprises (Chao, 2008). Moreover, the technological level and the capacities of the recipient countries affect technological spillover. Since the technological level and the capacities of Chinese enterprises are lower, it is very difficult for local enterprises to imitate technologies from MNC subsidiaries and to reduce the technological gap with them (Chao, 2008).

Auty (1994) argue that the Chinese government always expects to gain new technology through FDI. However, FDI has been concentrated in low-tech and labour-intensive industries, because foreign investors tend to utilise the low labour cost and favourable policies in China's economic zones. Leung et al (1991) and Lan and Young (1996) further consider that the important departments of MNCs are still in their home countries, such as the design department. Owing to the great mass of FDI having concentrated in the assembly of components, Chinese enterprises do not have a number of opportunities to learn and to promote their technological capacities.

Joint Venture

Adeoba (1990) defines the joint venture as a kind of business collaboration between local enterprises in the host county and the foreign partners. The Law of the People's Republic of

China on Chinese–Foreign Equity Joint Ventures (2001) defines joint venture as foreign firms, other economic groups or individuals joining with Chinese firms, enterprises or other economic groups in establishing joint ventures. In accordance with the principle of equality and mutual benefit, the joint venture shall take the form of a limited liability company. However, the proportion of the investment contributed by the foreign enterprises should generally not be less than 25% of the registered capital of a joint venture. The parties share the profits, risks and losses in proportion to their respective contributions to the registered capital.

The joint venture plays an important role in developing countries. UNCTAD's World Investment Report (2010) points out the 82,000 MNCs around the world and their 810,000 subsidiaries control over 80% of new technologies worldwide and operate 70% of technology transfer projects worldwide. The MNCs can bring majority of new technologies and capital if enterprises of recipient country and MNCs can cooperate to develop the market of the recipient country.

Joint venture can be seen as the main channel of ITT between developed countries and developing countries, which helps foreign investors to reduce or to avoid political risk and to enjoy preferential treatment such as preferential tax rates. The channel also helps Chinese enterprises to learn advanced technologies and utilise the international sales network of foreign investors to promote technological capabilities and develop international markets. In addition, joint venture also helps Chinese enterprises to learn foreign advanced management techniques and to improve the management level of domestic managers.

However, the joint venture also has some disadvantages, such as the internal conflict within an enterprise. Two parties of the joint venture come from different countries and regions, so they have different cultural backgrounds, political systems and legal institutions. It is difficult to avoid conflicts in the process of co-operation. Chao (2008) reviews that 70% of joint ventures are unhappy marriage in China, foreign enterprises are forced to cooperate with inefficient state-owned enterprises. In fact, foreign investors have already begun to abandon the joint venture and have tended to sole proprietorship. According to the data of the National Bureau of Statistics of China in 2005, there were 46 foreign enterprises of sole proprietorship in 1985, which accounted for 1.5% of the total. The amount of sole proprietorships exceeded joint ventures in 1997. Joint ventures had 9046 enterprises and sole proprietorship had 9604 enterprises, and only 27% of foreign investors selected the joint venture in 2006 (Sina, 2008).

The Asian American Coal Inc. (AACI), the Jincheng Daning Coal Co. LTD and the Subsidiary of Shanxi Coal Transport and Marketing Corporation (Jincheng Corporation) together set up the Chinese first coal joint venture (The Asian American Daning Energy Co. Ltd) in 2000 (investment ratio: 56%, 36% and 8%), with the total registered capital of 12 million US dollars and it was controlled by the United States. It formally put into production in 2007 and owned 2192 staff, and it is also the largest local coal mine in Jincheng of Shanxi Province. However, happy days do not last long, and due to various reasons, the US's the Asian American Cola Corporation withdrew all its investment and left the Chinese coal market after one year (Hexun, 2008).

Licensing Agreement

Jafarieh (2001) stresses that licensing is the most common channel of ITT, which mainly includes licensing of the patents, know-how and trademark.

The World Intellectual Property Organisation (WIPO, 2004) points out that licensing imply an agreement between licensors and licensees, which obtain and exchange approximately equal benefits and value. A voluntary license should be a win-win arrangement in order to be successful.

The State Intellectual Property Office of China (2006) defines the licensing agreement that licensors and licensees together sign a legal contract in order to confer the specified duration and payment of licensees' certain rights. The rights permit the licensee to use the industrial property rights of the licensor, including trademarks, patents and copyright. Kaynak (1985) points out the rights also include secret unpatented know-how, consisting of quality control and manufacturing methods. Since licensing offers flexible choices for licensor and licensee to negotiate and achieve mutual objectives, Kaynak thinks licensing is the most versatile mechanism for transferring technology. Moreover, the difference between licensing agreements and joint venture is that licensing agreements have no sharing of equity by the enterprises involved.

Frankel (1990) explains the incentives for the licensor and the licensee signs the licensing agreement; the intense competition among licensors lead them to sell existing technologies to licensees in order to gain funding for the R&D new technology and share the risk of technology innovation; the licensees also hope to avoid spending higher costs and longer time in R&D of a similar technology, additionally, through signing the licensing agreement with the transferor, the licensee is able to increase market share and gain faster business development. However, Porter (1988) considers that licensing is also discouraging the R&D of new technology. Lihua and Sun (2010) considers licensing as a strategic decision that is essential for licensors and licensees to develop an effective strategy of technology management, which needs timing, effective market and accurate forecasting. Moreover, Holstius (1993) points out the licensee may become the competitor of the licensor by utilising the know-how and expertise obtained through the licensing.

The World Intellectual Property Organisation (WIPO, 2004) summarised the following characteristics of technology licensing:

First of all, technology licensing takes place when one of the parties owns profitable intangible assets, assets which are also known as intellectual property (Figure 3.2). Moreover, the ownership has been protected by legal right, which can prevent the other party from using it.

Figure 3.2 (WIPO, 2004)

Secondly, the business market has different kinds of technology license, and the license can be divided into the following three categories (Figure 3.3).

Figure 3.3 (WIPO, 2004)

Third, technology licensing takes place in the context of a business relationship in which other agreements are usually important. These agreements are interrelated, they are in diverse documents or integrated in a large document. It is important to think over a practical way of how the terms of these related agreements influence each other because of the timing and the pricing (Figure 3.4).

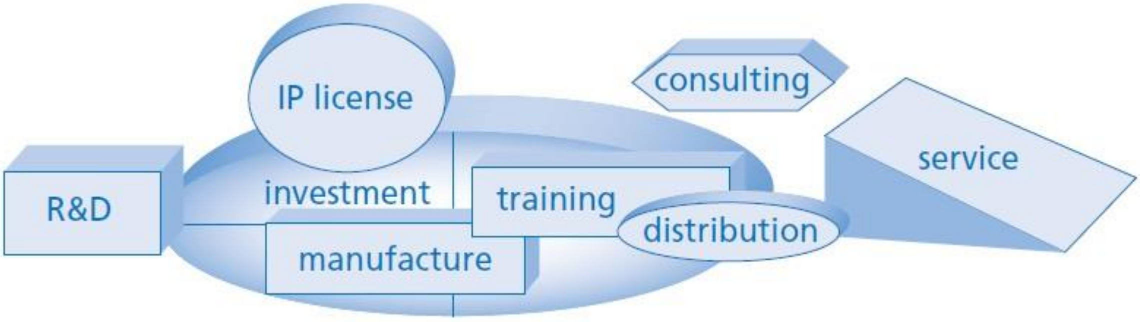


Figure 3.4 (WIPO, 2004)

Fourth, both parties (sides) of licensing have different interests and objectives in negotiations, but they should coincide in some ways. The purpose of negotiation is to find a good balance of value so that both sides are in a ‘win-win’ transaction (Figure 3.5).

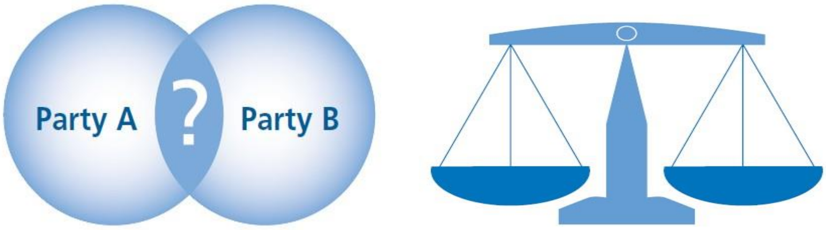


Figure 3.5 (WIPO, 2004)

Finally, technology licensing involves reaching agreement on a complicated set of terms, each of which has some solutions; hence, advanced preparation is very important (Figure 3.6).

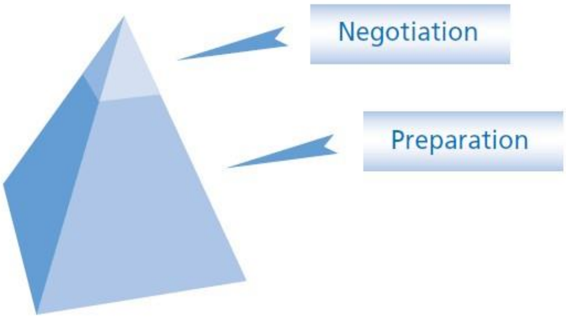


Figure 3.6 (WIPO, 2004)

This study has summarised the advantages and disadvantages of the licensee engaging in licensing as follows:

Advantages	**Disadvantages**
To save on R&D cost and time	Easily induce the technological dependence
To avoid the risk of R&D failure	Cannot immediately produce the goods
Can directly gain technology	Technological capacity of licensee has not been promoted automatically after licensing, it needs the process of learning and assimilating.

Patents and Patent Agreements

According to historical literature, the word patent originates from the Latin "litterae patentes", meaning an open letter. In medieval Europe, commercial monopoly privileges already existed, but privilege was bestowed by a monarch which is different from patents, in which the privilege is more like a franchise. King James I of England enacted 'The Statute of Monopolies' in 1624, and this statute was the first patent law in the world. Abraham Lincoln (1859) said that the patents system adds the fuel of interest to the fire of genius. The first Chinese patent law, the 'Copyright Law', was enacted by the Qing Dynasty in 1910.

However, the People's Republic of China enacted her first patents law (the Patent Law of the People's Republic of China) in 1984. Therefore, it shows China's patent protection has lagged behind in history compared with other parts of the world. The World intellectual Property Indicators 2009 of the World Intellectual Property Organisation (WIPO) pointed out the total number of global industrial design registrations was at approximately 512,000, and China's intellectual property office accounted for 26.2% of global industrial design registrations in 2007. It shows China has made enormous progress in the protection of patents.

Patents are a kind of intangible property, and it is also a main type of licensing. The patent is very important for the progress and development of national science and technology. Mark Twain (1889) said "That reminds me to remark, in passing, that the very first official thing I did, in my administration – and it was on the very first day of it, too – was to start a patent office; for I knew that a country without a patent office and good patent laws was just a crab, and could not travel any way but sideways or back ways." Stim (2009) defines the patent as a grant by the government, and the patent owner owns the legal right to maintain a monopoly for a limited period of time on the use and the development of an invention. In other words, the patent gives its owner or inventor the exclusive right of making, using and selling the invention, in the United Kingdom for 16 years, the USA for 17 years, Germany for 18 years and P. R. China for 20 years. Moreover, the Patent Cooperation Treaty (1970, PCT) of the World Intellectual Property Organisation (WIPO) points out that the inventors only propose an application of international patents; each signatory will protect patents if the investors obtain international patents.

Although the patents set up a legal barrier to avoid competitive imitation, we should understand the patent system is not perfect. To some degree, monopoly of patents limits sharing of knowledge and hinders technological innovation.

Zha and Chen (2010) point out that patent documentation covers 90% – 95% latest technical information of the world, and more than 70% of the patent information would not be published in papers and conferences; therefore, the transferee should regularly search the patent documentation before the start of ITT in order to improve the starting point and level of ITT.

Know-how and the Know-how Agreement

The International Chamber of Commerce (2002) states that know-how implies a package of non-patented practical information, resulting from experience and testing by the transferor, which is secret, substantial and identified.

Article 2 of 'Regulations of the People's Republic of China on Administration of Technology Introduction Contracts, 1987' defines the know-how as neither yet publicised nor under legal protection as industrial property, for manufacturing a product or applying a technology as well as for product designs, quality control, formulae, technological processes and management.

Article 10 of the Law of the People's Republic of China for Countering Unfair Competition (1993) considers know-how as akin to business secrets. It refers to technical and operational information which is not known to the public, and is capable of bringing business benefits to the holder, which the holder has taken measures to keep secret.

In summary, this study considers that know-how has the following three characteristics:

1. Know-how is an intangible property. It is the spiritual wealth of the originator.
2. Know-how is confidential. Its protection means are also confidential. Once it is disclosed, it will lose its foundation for existence. Moreover, it can be used alone, but can also combine patents with other technical knowledge to use together.
3. Know-how has teachability and transferability. Once it is applied to production and management of the industry, large economic benefits will be produced. Moreover, they will gain the same benefits with the holder of know-how if competitors also understand the know-how.

Wang (1996) claims that know-how has not obtained patent protection; this is mainly because the owner of know-how is unwilling to apply the patent in order to avoid disclosure of technical secrets. Therefore, know-how is weaker than the patent in the aspect of legal protection, as it does not have the monopoly of the patent.

The United Nations Industrial Development Organisation (UNIDO, 1979) argues the know-how agreement often provides enterprises in developing countries with a package of technical information needed for efficient assimilation and adaptation of the transferred technology.

Trademark and Trademark Agreement

The United States Patent and Trademark Office (2010) considers trademarks to be words, names, symbols, sounds, or colors or a combination of them, which serve to distinguish goods or services from different manufacturers. It also indicates the source of the goods. In other words, trademarks can let consumers know who makes the goods and who sells the goods.

Article 8 of the Trademark Law of the People's Republic of China (2001) defines that the trademark is able to identify different manufacturers' goods. It is a visual sign, such as the names, devices, combinations of colours, letters or numerals, three-dimensional symbols, or any combination of the above elements.

Stewart (1979) considers that trademarks can facilitate ITT. Because trademarks represent the reputation, level, quality and capability of the technology, they can facilitate the choice of transferors and transferees.

The Trademark Law of the People's Republic of China (2001) states that trademark agreement includes the content, features, the legitimacy and the effectiveness of the trademark, forms of recipient utilisation of the trademark, management of the trademark logo, and the superintendence of goods quality.

Guo (2010) argues that China has gained some progress in protection of trademarks in recent years, as the amount of trademark registrations increases every year, but China is still "a big manufacturing country, small trademark country". China has only a few reputable trademarks in the world, such as Lenovo, Haier and Huawei. A trademark is not only a logo, it is an indication of enterprise comprehensive strength. Global reputable trademarks account for 10% global trademarks, but account for 60% of global market share. The most reputable trademarks only account for 3% of global trademarks, but account for 40% of global market share.

Guo (2010) argues that China should improve the following aspects in order to promote the reputation of national trademarks:

- Establish the institution of comprehensive support and protection of trademarks through national power.
- Develop new policies to support independent innovation and R&D capability in order to encourage enterprises to develop unique trademarks.
- Strengthen the protection of IPR to encourage invention and innovation of enterprise.

Turnkey Contract

A turnkey contract means the builder or developer follows a contract to undertake the responsibility for carrying out a one-stop service of design, construction, providing equipment, installation and debugging, supplying material, training personnel and quality management. Once the project has been completed, the project will be turned over to the new owner. In other words, MNCs integrate the sale of plant equipments with ITT through signing turnkey contract (Clarck, 1993).

Hao (2003) believes that the turnkey contract is a complex combinatorial contract, which consists of licensing agreement, design contracts, civil engineering contracts and mechanical contracts. The contractor usually provides some additional contracts for the new owner, such as technical assistance contracts, management contracts and promotional contracts. The developer or builder cannot guarantee the new owner can master the necessary technology to achieve the manufacturability level of the developer or builder. In other words, even though the new owner obtains all of the plant equipment, it is difficult to achieve the desired objectives if the technical level of the new owner is low. Chinese enterprises try to increase the obligation of the builder or developer through adding new contract terms in order to overcome technical obstacles and achieve the manufacturability level of the developer or builder.

He and Gu (1996) claim that China often utilises turnkey plant in the early stages of industrialisation. Turnkey contracts provide the complete physical package of technology to China. It is also usually utilised in importing technology in China's heavy industries, such as the iron and steel industries.

Huang (2005) points out that Chinese enterprise gradually acquire knowledge and know-how through reverse engineering in turnkey contracts. Reverse engineering means Chinese enterprises can imitate the technology and goods of the builder or developer through technology spillover, but Chinese enterprises find it difficult to acquire tacit knowledge through turnkey agreements. Therefore, China's heavy industries have a gradual tendency towards replacing turnkey agreements with licensing agreements in order to acquire more know-how for technology promotion.

Management Contract

The United Nations Conference on Trade and Development (UNCTAD, 1987) defines the management agreement as an arrangement in which the managerial control of a corporation is vested by agreement. It carries out the necessary operational functions in return for a fee in logistics management, human resource management and management of production.

According to Yang (2004), management contracts are where MNCs sign an agreement with the enterprises of recipient countries and send professional technology or management staff to involve daily management in order to improve the management level and the productivity of recipients.

Yousef (1988) thinks the management agreement is a channel of ITT, which transmits a large amount of management knowledge and many skills to the enterprise of the recipient through staff training projects or working together with the staff of the supplier. Its disadvantages are the diverging purposes of the transferor and transferee regarding the management and duration of the programme.

International Subcontracting

Jafarieh (2001) considers subcontracting is an informal ITT mechanism. The United Nations Industrial Development Organisation (1999) points out ITT in international subcontracting, often through a license, implies the transfer of knowledge through proper supports, for instance, specifications of manufacturing processes and training programmes. Chen and Liu (2006) defined that international subcontracting means the enterprises of developing countries follow the requirements of the enterprises of developed country to manufacture goods or provide services. Radosevic (2004) considers an important characteristic of international subcontracting to be the coupling of export goods and ITT; it plays the role of the training school.

Chen and Liu (2006) argue that China role as a “world manufacturing factory” is an important characteristic of international subcontracting. International subcontracting is the main cause of the explosive growth of China’s international trade; more than half of its international trade is from international subcontracting. According to the statistics of the General Administration of Customs of China (2010), exports and imports of the Chinese textile and garment industries achieved 167.07 and 16.82 billion dollars respectively in 2009, accounting for 13.9% and 1.7% of the total amount of China’s exports and imports; these data show the development of many industries still at the international subcontracting stage.

International subcontracting has been rarely adopted in the coal mining industry, while it has always been adopted in manufacturing industry.

Franchising Agreement

The Ministry of Commerce of the People's Republic of China promulgated 'The Measures for Administration of Commercial Franchise' in 2004; Article 2 defines franchising as the franchisor permitting the franchisee to use its business model, managerial concept and trademark through a signed franchising contract; the franchisee pays the franchisor a fee for franchising.

The United Nations Industrial Development Organisation (2008) considers that franchising has been an effective way for enterprises to expand their operations globally. It is a certain form of licensing, but franchising and licensing are different. According to the proportion of investment, franchising can be divided into voluntary chain, license chain and franchise chain.

The United Nations Industrial Development Organisation (2008) implies franchising means franchisors transfer the whole business concept to the franchisee and allow the franchisee to reproduce the whole business model according to same concept, production engineering, quality standards and logo. The franchisee should pay a franchising fee to the franchisor when they signed the franchising agreement. Franchising has an important characteristic, enterprises of the franchisee are not branches or subsidiaries of the franchisor. Enterprises of the franchisee are independent operations and self-financing, and the franchisor cannot guarantee that the enterprises of the franchisee will be profitable. Franchising is a kind of long-term agreement; it has been used in the hotel and fast food industries, such as Hilton and Subway, but it has been rarely adopted in the coal mining industry.

The franchising agreement has similar characteristics to the trademark and management agreement, but Jafarieh argues (2001) that the institutional structures and law of some developing countries cannot protect franchising. This leads to franchisors of developed countries being unwilling to franchise technology to recipients in developing countries.

Imports of Capital Goods and Machinery

Jafarieh (2001) stresses the import of capital goods and machinery is a major ITT channel, which is usually used by developing countries. It can develop the local technological capability of the recipient country, but it depends on the level of industrial development, technical personnel, and absorptive capacity of the recipient country. Hoekman (2005) says that technology trade contributes to ITT by allowing local reverse engineering to imitate the new machinery and equipment of supplier countries. The machinery import history of the Chinese coal mining industry will be reviewed in section 2.10.

3.3 Analysis of the Channels and Mechanisms

Foreign direct investment, joint venture and licensing are known as the three most common channels adopted by ITT in China. However, FDI and joint venture are gradually withdrawing from China's technology market, and licensing as the most versatile channel of ITT is taking its place. In particular, foreign technology has always been transferred to Chinese state-owned coal mines through licensing rather than foreign direct investment and joint venture. This is attributed to the fact that 49.6 percent of China's energy consumption is from coal (BP Statistical Review of World Energy, 2012). Coal in China as a kind of national strategic resource takes up a pivotal position (China Coal Industry Association, 2013). The Chinese government formulated a series of policies to protect state-owned coal mines to gain substantial coal resources, and these policies essentially limited foreign enterprise to invest and control coal resources in China (Wang, 2010). This leads to the fact that the coal mining industry finds it very difficult to attract foreign investment (Wu, 2008). In addition, the joint venture can only be set up under Chinese party majority holding when foreign enterprises wish to set up joint ventures with Chinese coal enterprises. The above reasons may lead to the fact that foreign enterprises find it very difficult to participate in development of the coal mining industry in China.

In the next chapter, the researcher will discuss the design and choice of research methodology in order to ensure all research objectives are fully achieved and the research questions have been fully answered.

Chapter Four – Research Philosophy and Methodology

4.1 Introduction

As the previous two chapters have outlined the problems in the Chinese coal mining industry and reviewed the relevant literature with regard to ITT in the Chinese coal mining industry as well as identified the research gaps in this field, this chapter is going to give an account of the methodological issues related to this study and explain in detail the choice of the research methods used for the current research as well as the procedures used for data collection. It offers an exploration of the key concepts underpinning the research design, sampling techniques, and research tools for data collection, techniques of data analysis, as well as the validity and reliability of the current study. The consideration of ethical issues will also be discussed. Based on these considerations, both the case studies approach and the survey approach, as used for the current study, will be discussed and elaborated in detail. Finally, the validity and reliability of the current research will be discussed followed by a conclusion.

4.2 Research Questions

The primary purpose of this research is to investigate the factors that impact on the effect of ITT in the Chinese coal mining industry. According to Creswell (2009), it is useful for a research question to contain one or two main questions which represent a research enquiry into the issue being investigated in its most general form, followed by sub-questions that narrow down the focus of the study. Therefore, having identified the purpose of the research in the introductory chapter, it is now important to state the research questions.

The following questions emerged as the focus of this study which will be carefully looked at and investigated.

Main Research Question:

What are the main factors that affect the effectiveness of ITT in the Chinese coal mining industry?

The following sub-questions need to be answered in order to answer this main question:

Sub-Questions:

Why is ITT necessary for the Chinese coal mining industry?

How has foreign technology been transferred into the Chinese coal mining industry?

What factors affect the effect of ITT in the Chinese coal mining industry?

What are the implications of the relationship between the main influencing factors and the effect of ITT?

These sub-questions aim to answer the main research questions from multiple perspectives. The first sub-question aims to explore the demand and opportunity of ITT in the Chinese coal mining industry. The second sub-question tries to understand the channels and process of ITT in the Chinese coal mining industry. As ITT is a very complex process, each ITT channel has different characteristics and therefore deserves to be clearly investigated. The second sub-question also attempts to answer the channels that have been adopted frequently to obtain foreign technology in order to focus on the channel to analyze the process of ITT. In addition, each process has a number of steps, and it may affect the effectiveness of ITT if any steps of the process appear to be problematic. An understanding of the process is very helpful to identify which steps appear be problematic. The case studies play a primary role in answering the first two sub-questions; it also works together with survey to answer the third sub-question and intends to identify the factors affecting the effect of ITT. Results of survey will also answer the fourth sub-question and allow the researcher to understand the implications of relationship between the main affecting factors and the effect of ITT. Having stated the main and sub-research questions, it is now necessary to discuss the research philosophy upon which this study is based.

4.3 Research Philosophy and Paradigm

Denzin and Lincoln (2011) claimed that the research philosophy is a stance taken by the investigator to provide a basic set of beliefs and undertakings that guide research enquiry both implicitly or explicitly. Velasquez (2010) considered that the first step in carrying out research should understand the research philosophy and decide on a proper research paradigm in order to guide the research settings and choices. Criticism among positivism, post-positivism, pragmatism and constructivism induces the researcher to carefully considere how research should best be done and which research philosophical stance should be chosen. Many researchers argued that these complex philosophical stances are based on two traditions of research enquiry: qualitative and quantitative enquiries (Tesch, 1990; Bryman, 1993; Robson, 2002; Denzin and Lincoln, 2003; and Creswell, 2009). Denzin and Lincoln (2011) remarked that research methods cannot be considered in isolation from the epistemological, ontological and axiological position adopted by the researcher. Therefore, this research considered employing the epistemological, ontological and axiological position of pragmatism, which suits this study in the most appropriate way.

Pragmatism is a philosophy of science that stresses the link between action and truth, asserting that the ultimate test of a belief is the willingness to act on it (James, 1907; Dewey, 1929; Peirce, 1992, 1998; Baert, 2005; Calcaterra, 2011). Further, Fendt et al (2008) stated that the purpose of pragmatism aims to create useful knowledge through addressing contemporary problems and translating acquired knowledge into action. It was also able to accept all well-defined paradigms of scientific enquiry as valid when they are appropriate, that is where the nature of studied reality is such that the paradigm leads to useful results. Compared with the main paradigm of social science, pragmatism may combine deductive and inductive thinking, as the researcher mixes both quantitative and qualitative data (Table 4.1 Tashakkori, 2006). Tashakkori and Teddlie (2003) pointed out that pragmatism was embraced as the best philosophical foundation for mixed methods research.

Compared With Main Paradigm of Social Science				
Paradigm	Positivism	Post-positivism	Pragmatism	Constructivism
Method	Quantitative	Towards Qualitative	Quantitative + Qualitative	Qualitative
Approach	Deductive	Towards Deductive	Deductive + Inductive	Inductive

Table 4.1 Compared with Main Paradigm of Social Science (Tashakkori, 2006)

Therefore, this study adopted pragmatism as the research standpoint, where the mixed methods of the case studies approach and the survey approach were employed as the philosophical partner to investigate ITT in the coal mining industry in the Chinese context. The understanding of these enquiries will better help to systematically use these methods for data collection, data analysis and interpretation and therefore better serve to answer the research questions. Thus, it is now necessary to elaborate how the mixed methods were used as a research strategy for this study.

4.4 The Choice of Research Strategy

Saunders et al (2008, p.136) considered that the research strategy provides the most efficient way of collecting useful information, and the strategy will result in the best possible answer to the research question. Research strategies can be divided into three kinds: qualitative, quantitative, and combined (Bryman, 2006). Each of these strategies provides the researcher with different yet useful data-gathering methods and data processing and analysis techniques (McNabb, 2008). Comparing the quantitative approach with the qualitative research strategies (Table 4.2), quantitative research emphasizes quantification in the collection and analysis of data whereas the qualitative research strategy usually emphasizes words rather than quantification in the collection and analysis of data (Bryman and Bell, 2007).

Fundamental differences between quantitative and qualitative research strategies

	Quantitative	Qualitative
Principal orientation to the role of theory in relation to research	Deductive; testing of theory	Inductive; generation of theory
Epistemological orientation	Natural science model, in particular positivism	Interpretivism
Ontological orientation	Objectivism	Constructionism

Table 4.2 Comparison of the quantitative and qualitative research strategies (Bryman and Bell, 2007, p.28)

The mixed (combined) approach, however, according to Johnson and Onwuegbuzie (2004) is a third research paradigm known to be a profoundly comprehensive technique for research in social sciences through the integration of quantitative and qualitative research methods.

Currall and Towler (2003) stated that researchers in management have strongly oriented towards adopting quantitative data with statistical analysis for the purpose of theory testing.

There was, however, a few who adopted qualitative or mixed methods strategies. Owing to management research requiring a large variety of questions to be answered, drawing on numerous theoretical paradigms from a range of disciplines, and characterized by investigations involving multiple levels of analysis, it is quite beneficial to combine the complementary strengths of quantitative and qualitative approaches (Currall and Towler, 2003) as management research is becoming increasingly complex and intricate, requiring new techniques for examining research problems and analyzing data to explain and clarify social phenomena (Jogulu and Pansiri, 2011).

In recent years, the usefulness of the mixed methods approach has begun to be widely recognized and hence has been adopted by many management scholars (Cameron and Miller, 2008, 2010, 2011; Molina-Azorín, 2011; Jogulu and Pansiri, 2011), although scholars argue that mixed methods is still in its infancy and still needs to reach maturity (Bazeley, 2008; Teddlie and Tashakkori, 2008). Nonetheless, social sciences are showing progressive acceptance of mixed methods (Hammersley, 1996; Greene, 2007; Creswell, 2009; Creswell and Clark, 2010). According to Creswell and Clark (2010, p.5), mixed methods were defined as follows: "the researcher collects and analyzes persuasively and rigorously both qualitative and quantitative data (based on research questions) and integrates the two forms of data concurrently by combining them, sequentially by having one build on the other, or embedding one within the other; gives priority to one or to both forms of data (in terms of what the research emphasizes); uses these procedures in a single study or in multiple phases of a program of study; frames these procedures within philosophical worldviews and theoretical lenses." This research tried to employ mixed methods as the research strategy in the methodology of this research. The following paragraphs explain the rationale for the use of mixed methods.

Bryman (2004) argued that so far as research practice is concerned, the combination of quantitative and qualitative research methods has become commonplace in recent years. This combination is named multi-methods (Brannen, 1992), multi-strategy (Bryman, 2004), mixed methods (Creswell, 2003; Tashakkori and Teddlie, 2003), or mixed methodology (Tashakkori and Teddlie, 1998) research, indicating an adoption and employment of more than one type of research method (Tashakkori and Teddlie, 2003; Fielding and Fielding, 2008; Brannen, 2008).

In social research, research strategies can be divided into case study, survey, experiment, action research, grounded theory, ethnography, and archival research (Saunders et al., 2008). Each strategy can be used for exploratory, descriptive and explanatory research (Yin, 2003). Some of those strategies listed above clearly belong to the deductive approach, while others belong to the inductive approach. However, the use of only one approach is unduly simplistic (Saunders et al., 2008). More importantly, it is not the label that is attached to a particular strategy, but whether it will enable the researcher to answer the particular research questions and meet the research objectives (Saunders et al., 2008). Therefore, the decision of the appropriate research strategy for a particular research setting relies mainly on the type of research questions and research settings one has opted for (Robson, 2002; Saunders et al., 2008). Saunders et al (2008) further remind us that these strategies should not be thought of as being mutually exclusive.

Mixed methods can create divergent findings through different data collection methods and analysis techniques, which will lead to depth and breadth in the overall results, from which researchers can make more accurate inferences with increased credibility (Jogulu and Pansiri, 2011). Moreover, mixed methods advocate the use of both inductive and deductive research logic, which is a great strength. Having an inductive-deductive cycle enables researchers to equally undertake theory generation and hypothesis testing in a single study without compromising one for the other. Through integrating the deductive-inductive dichotomies, researchers can provide better inferences when studying the phenomenon of interest (Jogulu and Pansiri, 2011). In fact, it is essential that research is able to have sophisticated research designs, multiple data sources, and analysis that create views and findings from multiple perspectives (Jogulu and Pansiri, 2011). All these can be achieved through the use of mixed methods. Moreover, Greene (2007, p.100-103) also summarized that triangulation, complementarity, development, initiation and expansion are five main purposes or rationales for conducting mixed methods research.

First, methodological triangulation provides opportunities for a researcher to examine the same social phenomena by using multiple methods (Greene, 2007). In the current research, observation, semi-structured interview and self-completion questionnaire are adopted as methods to collect data for answering the research question: what the main factors affecting the effectiveness of ITT in the Chinese coal mining industry? By adopting these three methods, findings can be presented from different perspectives to ensure both the credibility of the responses obtained and the validity of data. Second, the objective of complementarity is to provide a more comprehensive investigation of the research question by different methods from different angles (Greene, 2007). The current research combined a qualitative with a quantitative approach in order to compensate for the deficiencies of the methods used and to maximize the validity of data. Third, development means that the result of one method is used to guide the development of the other method (Greene, 2007). In this research, the findings of observation helped the researcher to develop the questions of semi-structured interview, and the findings of semi-structure interview helped the researcher to develop the questions of self-completion questionnaire. Fourth, initiation allows opportunities to discover the paradoxes and contradictions emerging from data (Greene, 2007). The investigation of the research questions by using different approaches allowed the research to recast the questions and results from one method with questions or results from another method. Finally, expansion is demonstrated by using the mixed methods approach to ensure the depth and breadth of data because each method used can address different aspects and components of the research questions (Greene, 2007). In this research, self completion questionnaire has been adopted to measure correlations between ITT effect and the main affecting factors. In addition, observation and semi-structured interview have been adopted to understand the demand and opportunity as well as the process of ITT.

In sum, this study adopted a mixed methods strategy by a combination of case studies strategy and survey strategy. The use of the case studies strategy is to answer the first two research sub-questions. The survey strategy, however, is designed to answer the latter two research sub-questions. The mixed methods strategy has been argued as the most suitable research strategy for the current project from multiple perspectives to serve to answer the research questions as it offers creative possibilities for addressing research questions in terms of various research methods. The following paragraphs explain the rationale for the use of case studies strategy as the first part of mixed methods strategy.

Social science research methods can be categorized into five kinds: case study, survey, experiment, archival analysis and history (Yin, 2003). The decision of the strategies used for a particular research study depends on the types of research questions (Robson, 2002; Saunders et al., 2008). According to Hedrick et al (1993), research questions fall into five basic categorizations: “who”, “what”, “where”, “why”, and “how”. The types of questions that a research is focused on indicate the different enquiries, and therefore require different strategies to fulfill the research endeavour (Hedrick et al., 1993). With regard to the first two sub-questions of this study, the type which is about “how” and “why”, with the objectives to depict a overall picture of ITT in the coal mining industry in the Chinese context, Yin (2009) stated, case study typically answers the type of research question such as “how” or “why”. Schell (1992) further claimed that “how” and “why” questions are more explanatory in nature and are likely to lead to conducting case studies, histories and experiments. The current research focuses on contemporary social phenomena: an industry whose historical background may have a heavy impact on how the industry uses ITT. Yin (2009) considered that case study is an empirical enquiry, in which the focus is on a contemporary phenomenon within its real-life context, and therefore case studies is considered suitable for studying complex social phenomena of ITT in the Chinese coal mining industry.

Employment of case studies strategy as the first part of mixed methods strategy for answering the first two research sub-questions is due to its appropriateness for the current research, and other research strategies might be unable to reflect and support the research purposes of the first part. As mentioned previously, this research needs to understand ITT activities within the wide context of the Chinese coal mining industry. It involves collecting a variety of data which is contextualized in nature; however other research methods, for example the survey type of research, are usually limited to focusing on influencing factors which were pre-hypothesized from the perspective of positivism, and collecting systematically quantifiable data in respect of a number of variables which are then examined to discern patterns of association (Bryman, 2004). If the first part used survey as a strategy, it would prevent the researcher from exploring the full richness and variety of issues involved in ITT activities in the Chinese coal mining industry, and consequently would lead to wrong or inconsistent conclusions.

Moreover, Prasad (2005, p.4) stated that researchers in international business and management typically rely on a case study approach that could be characterized as "qualitative positivism", and which is loosely derived from the guidelines set out by Eisenhardt (1989) and Yin (2009). Qualitative case study is conducted by spending a substantial time on site, personally in contact with activities and operations of the case reflecting the occurrence of what is going on (Stake, 1995). Meanwhile, case studies allow for rich empirical descriptions of particular instances of a phenomenon that are typically based on a variety of data sources (Yin, 1994) and it is an approach researching a situation where the phenomenon and the context are entangled but where this entanglement is pertinent to the study.

Piekkari (2011) synthesized dimensions of the case study commonly mentioned in the methodological literature. First of all, the case study is usually described as a research strategy rather than a method or methodology (Eisenhardt, 1989; Mills et al., 2010). It can be used in conjunction with different methods and methodologies. Secondly, it combines a range of data sources (Creswell, 1994). Thirdly, its focus is on a single entity, event, instance or phenomenon (Creswell, 1994; Stake, 1995). Fourthly, this phenomenon or event is placed in its context (Yin, 2009), and finally, the purpose of the case study is to "generate theory and/or contribute to extant theory" (Mills et al., 2010, p. xxxii). This study hopes to contribute to extant theories by testing them in order to understand whether the existing theories fit the Chinese coal mining industry. Therefore, a cases studies strategy as the first part of a mixed methods strategy has been adopted in this study. The following paragraphs discuss the rationale for the survey strategy as the second part of mixed methods strategy.

Sample survey is considered to be one of the most important basic research methods in the social sciences, which consists of (relatively) systematic, (mostly) standardized (Marsden and Wright, 2010, p.3) types. A survey is not just a particular technique for information collection. Questionnaires are widely used, however other techniques such as structured and in-depth interview, observation, and content analysis can also be used in survey research (deVaus, 2002). Marsden and Wright (2010, p.3) identified four basic developments considered to be the core of the sample survey method:

- Sampling: surveys draw representative samples from human populations whose observed characteristics provide unbiased estimates of the characteristics of those populations.
- Inference: the theory of statistical inference allows generalization of sample statistics to estimate population parameters within calculable margins of error.
- Measurement: “The art of asking questions” (Payne, 1951, p. xi) and strategies for writing questionnaires seek to elicit valid and reliable answers about a wide variety of subjects.
- Analysis: multivariate data analysis techniques and the associated computational power enable the estimation of complex statistical relationships among many variables and adjustments for many other sources of uncertainty in survey data.

The survey approach is usually associated with the deductive approach, which is commonly used in business and management research and is the most frequently used method to answer the questions of who, what, where, how much and how many (Saunders et al., 2008). Surveys are popular as they allow the collection of a large amount of data from a sizeable population in a highly economical way. Saunders et al (2008) stated that surveys are often obtained by using a questionnaire administered to a sample, and these data are standardized, allowing easy comparison. Thorpe et al (2008, p.90) considered “inferential surveys predominate in academic management research”. This study adopted the inferential survey and the reasons are listed following.

The first reason for selecting a survey was due to the nature of the research question of this study, which was an inferential question that aimed to infer the main factors affecting the effect of ITT in the Chinese coal mining industry. The second reason was that the current study tries to consider testing a hypothesized relationship in a much wider context in the Chinese coal mining industry which can provide findings for the phenomenon under investigation instead of specific and particular results from several individual cases. Third, this research hopes to understand the implications of the relationship between ITT effect and the main affecting factors. Therefore, the survey approach was considered as the most appropriate research method for the current research.

4.5 Research Design

As the previous section depicted the methodological basis of this study, this section will articulate how case studies and the survey approach fitted into this research design to serve for the research questions to be answered. Bryman and Bell (2007) considered the research design provides a framework for data collection and analysis. The framework then provided clear guidance for the researcher on how the major parts of the research data and methods work together to answer the research questions (Trochim and Donnelly, 2006). Figure 4.1 below presents an overview of the research process and design.

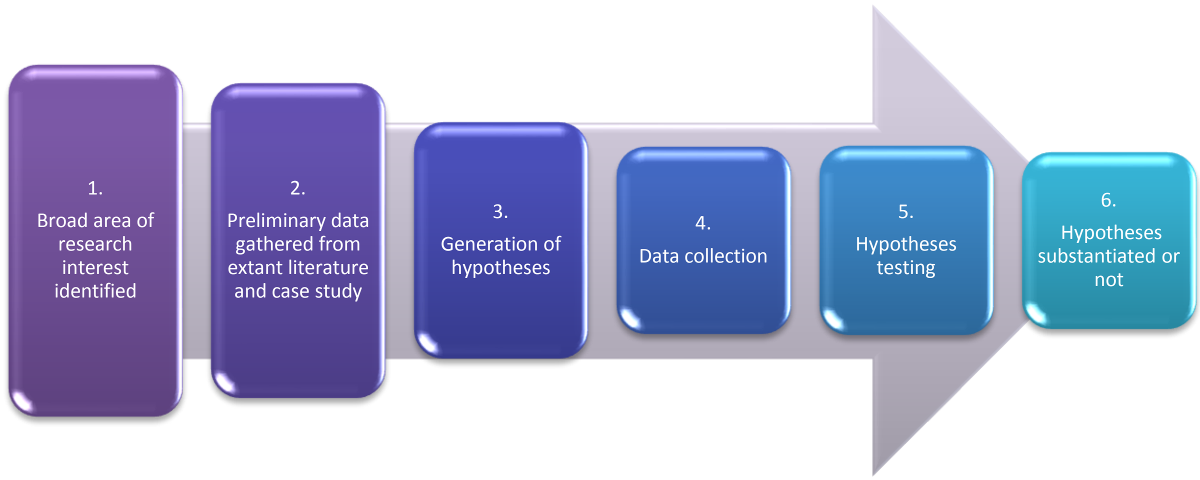


Figure 4.1 Illustration of the research process and design

The design of this study is mainly based on the scant literature on ITT in the Chinese coal mining industry. The literature review indicated a theoretical gap between ITT and the Chinese coal mining industry. The existing theories of ITT have been developed based on the other context or industries rather than the Chinese coal mining industry. Validity and reliability of the existing theories should be further demonstrated and elaborated through the case study if the current research hopes to adopt the theories to generate hypotheses. In addition, the substantiation of hypotheses adopted the survey strategy through self-completion questionnaire to measure the causal relationships between ITT effect and the main affecting factors. The design of the survey enables the researcher to generalize the qualitative findings beyond the specific case.

4.5.1 Case Studies

Case study is an ideal research method when a holistic, in-depth investigation is needed (Feagin, Orum and Sjoberg, 1991). Yin (2009) further considered case study is also the method of choice when the phenomenon under study is not readily distinguishable from its context. The current research focused on understanding the necessity, channel, process and affecting factors of ITT in the coal mining industry in the Chinese context; these aspects involve a number of complex issues related to the social and industrial context. Case study is able to collect and analyse relevant information through conducting observation and semi-structure interview in order to understand the real situation of these aspects. It should be noted that within the case studies, two stages of case studies were conducted: the pilot stage and main case studies.

Pilot Studies

Pilot study was considered to be useful and even 'invaluable' in qualitative research and it has been widely used to collect background information and to adapt the research approach (Fuller, 1993). It is essential to give the research a trial run, otherwise there is no way to ensure the research is running successfully (Bell, 1999). In case study, Yin (2009) considered that a pilot case study helps researchers to refine the data collection plans; it can be so important that more resources may be devoted to this phase of the research than to the collection of data from any of the actual cases. Moreover, Glaser and Strauss (1967) argued the provisional findings gathered from the pilot case can also be useful in establishing a chain of evidence for the later main research. The criteria for choosing a pilot case are based on convenience, accessibility and geographic proximity (Yin, 2009).

Creedy et al (2006) stated that coal mines in China traditionally have three classifications in terms of production and ownership:

- Key (large) state-owned coal mines
- Local state-owned coal mines
- Small-scale township and village coal mines
-

In general, a large state-owned coal enterprise has appropriately ten subsidiaries. The ten subsidiaries, however, are the ten large state-owned coal mines. In other words, a large state-owned coal enterprise is composed of ten large state-owned coal mines. Similarly, local and small coal enterprises have the same structure as large state-owned coal enterprises.

Each coal enterprise contains a number of coal mines, so Wang and Zheng (2008) recommen ded that research on the coal mining industry should consider the representational coal mine a s a unit of case study rather than coal enterprises, because the coal mine is a fundamental unit of the Chinese coal mining industry, and the entire production and operation activities of a c oal enterprise are performed by each of its coal mine. Therefore, the following three coal mines have been chosen as cases by sampling logic in the pilot study, the researcher anonymized them as coal mine A1, coal mine B1 and coal mine C1 for ethical reasons.

- Coal mine A1 (large state-owned coal mine)
- Coal mine B1 (local state-owned coal mine)
- Coal mine C1 (small-scale township and village coal mine)

These mines were chosen to conduct pilot case studies for two reasons: first of all, these mines have had experience of ITT in recent years; secondly, these mines are very typical coal mines, representing the large state-owned coal mine, local state-owned coal mine and small-scale township and village coal mine respectively. The pilot study was designed in the current research to allow the researcher to:

- Identify more reliable resources of data and key informants than the current three coal mines;

- Assess the reliability of selected data collection techniques;
- Assess the appropriateness of the selected data analysis techniques;
- Refine and further develop appropriate interview questions and prevent leading questions in the interview of the main case studies;
- Assist the researcher to further understand the subject in its real context.

The source of data collection for the pilot study included archival and internal documents of three coal mines, presentation materials from leaders and managers of three coal mines, publications about the three coal mines as well as semi-structured interviews, direct or indirect observations, informal conversations, field notes and e-mail correspondence.

Main Case Studies

In terms of design, it is important for a research study to determine the types of a case, whether to examine a single case, multiple cases, or several cases embedded within this research (Salkind, 2010). Yin (2009) pointed out that each design has significant strengths and weaknesses. Single and multiple case designs can lead to a successful case study. In general, criticisms about single case studies usually reflect fears about the uniqueness or artifactual conditions surrounding the case. As a result, the criticisms may turn into skepticism about the researcher's ability to do empirical work beyond having done a single case study (Yin, 2009). Single case design is "eminently justifiable under certain conditions", including "when the case represents: (a) a critical text of existing theory (b) rare or unique circumstances, (c) a representative or typical case or when the case serves a (d) revelatory or (e) longitudinal purpose" (Yin, 2009, pp. 47-49). Yin (2009, p.46) further elaborated that "a major step in designing and conducting a single case is defining the unit of analysis or the case itself", and "to ensure that the case in fact is relevant to the issues and questions of interest". The holistic design is advantageous when the relevant theory underlying the case study is itself of a holistic nature (Yin, 2009, p.50). The current study adopted single case (holistic) design based on the nature of the research question. In addition, three representative cases were chosen as the main case studies by sampling logic. The selection criterion of the three cases will be discussed in the next paragraphs.

Case Selection

Case selection is a critical step in research design (Mills et al., 2010; Piekkari, 2011). Coal mines in China are traditionally classified into three types: KSOCM, LSOCM and TVCM in terms of size (or production) and ownership (Creedy et al., 2006). Accordingly, any attempt to understand the whole Chinese coal mining industry should consider the three kinds of coal mine. In this regard, the researcher chose one typical coal mine from each of the three classifications as three representatives to conduct the current study.

The selection of representatives within each classification is set to follow the guidance of the case screening process in a single case study design suggested by Yin (2009). The single case study chose the case that is likely, all other things being equal, to yield the best data (Yin, 2009). Therefore, three factors were taken into consideration: representativeness, comparability and ITT intensity.

Representativeness concerns whether a coal mine can represent the characteristics of the classification. Wang (2001) argued that whether a coal mine can be representative of the coal industry depends on whether a coal mine can reflect development history and characteristics of the coal industry. Wang and Zhao (2004) further considered a representative coal mine not only displays the vicissitudes of the process of the coal mining industry of New China but also maintains sustainable development in the future. If a coal mine is about to run out of resources, even though it meets the criteria of the representative case, it is of no significance. Moreover, the classification criteria of coal mine evaluation should consider its production, employees and total assets (Wang and Zhao, 2004). Therefore, representativeness in this study means the coal mine can meet the following three criteria:

- It can represent the character of the classification by production, employees and total assets.
- It can display the developmental history of the coal mining industry.
- It can maintain sustainable development in the future.

Pingdingshan was planned to be the first Chinese large coal city by the State Council in 1952 (China Coal Industry Yearbook, 2002), and then Pingdingshan was listed as one of the top ten large coal cities by the State Council in 1953 (Yang, 2010). It is also called the "coal bunker in the central plains of China" (Liang and Lu, 2008, p.2). Currently, China has 13 coal bases whose coal production reached 2.8 billion tons in 2010, which accounted for 87% of the national coal output (China Coal Industry Yearbook, 2010). Henan coal base has been paid more attention by the State Council as the representative of 13 coal bases (Nan and Zhu, 2010). Pingdingshan coal city is the most important component of Henan coal base based on its production and history (Liang and Lu, 2008). The red in Figure 4.2 shows the location of Pingdingshan coal district. Therefore, based on above three criteria, the research was located in the Pingdingshan coal city for selecting the three representative coal mines (Figure 4.2).

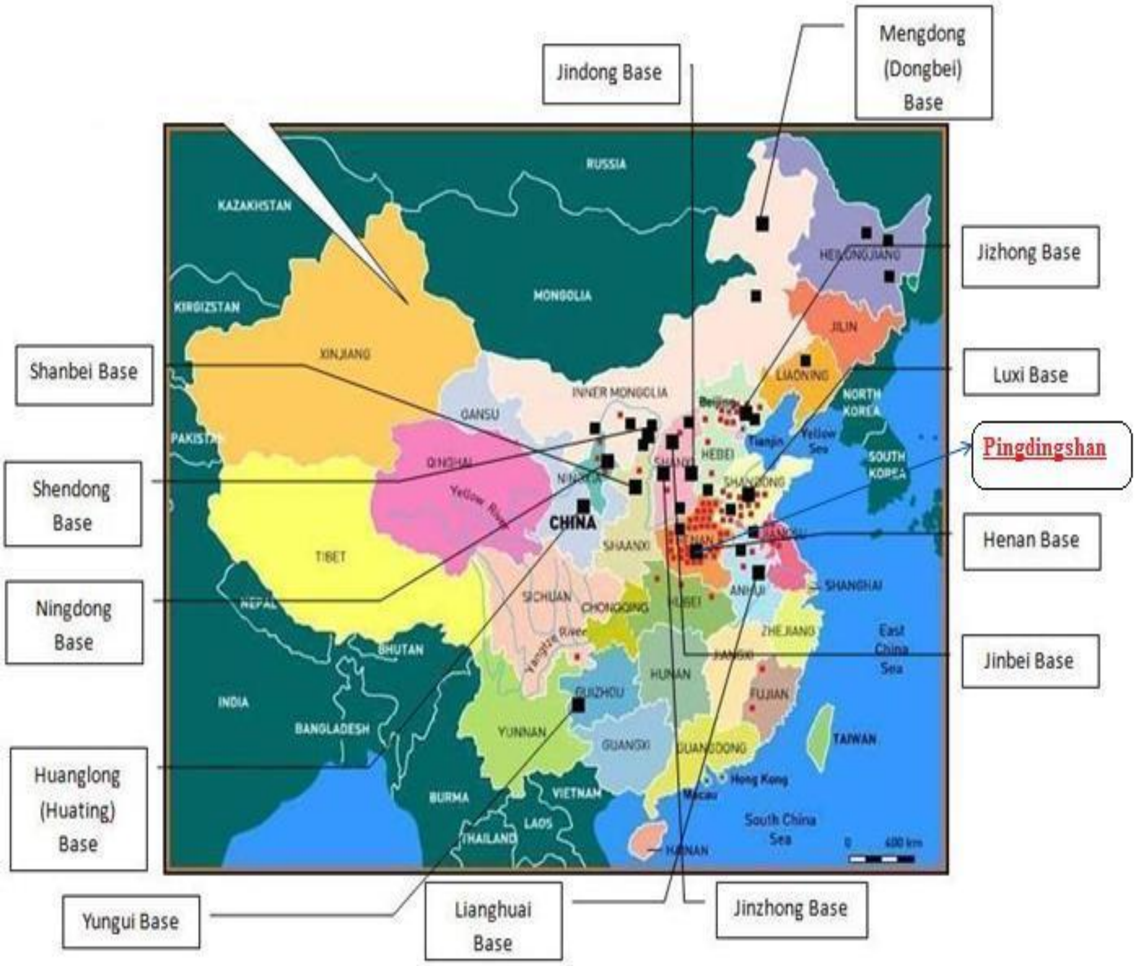


Figure 4.2 The 13 large coal bases in China (cases from red)

Source: China Coal Industry Yearbook 2008

Pingdingshan coal city has nine large state-owned coal mines, which has been shown in Table 4.3 and arranged by time of establishment (China Coal Industry Yearbook 2009). The researcher anonymized them as coal mine A2, coal mine A3, coal mine A4, coal mine A5, coal mine A6, coal mine A7, coal mine A8, coal mine A9 and coal mine A10 for ethical reasons. Compared with the nine large state-owned coal mines, coal mine A2 and coal mine A3 can be representative of large state-owned coal mines from production, employees, total assets and developmental history (Table 4.3). Because the coal resources of coal mine A2 have almost been exhausted in recent years (Zhang, 2010), coal mine A3 is considered as representative of large state-owned coal mines because it was established in 1954, which is regarded as an early large state-owned coal mine self-constructed and developed by China. The coal mine had Soviet technological assistance and thereby to develop R&D capability itself, it represented the developmental history of China’s coal mines. Moreover, the researcher compared ITT intensity (ITTI) of coal mine A3 with eight large state-owned coal mines based on data of the pilot study. ITTI is the frequency of ITT, which is the amount of ITT projects an organisation engages in within one year (Wang et al., 2009). Compared with nine large state-owned coal mines, coal mine A3 is more suitable than other coal mines as representative of large state-owned coal mines.

Time	Name	ITTI	Production (YR)	Employees	Total Assets (RMB)
1953	Coal mine A2	12	1.6 Million Tons	2,206	180 Million
1954	**Coal mine A3**	26	2.8 Million Tons	3,820	260 Million
1960	Coal mine A4	22	2.8 Million Tons	3,743	260 Million
1965	Coal mine A5	25	2.8 Million Tons	3,521	250 Million
1982	Coal mine A6	21	2.2 Million Tons	3,147	220 Million
1985	Coal mine A7	20	1.8 Million Tons	2,753	190 Million
1988	Coal mine A8	17	1.6 Million Tons	2,521	180 Million
1990	Coal mine A9	27	3 Million Tons	4,080	280 Million
1995	Coal mine A10	32	3 Million Tons	3,612	260 Million

Table 4.3 Nine large state-owned coal mines located in Pingdingshan

Source: China Coal Industry Yearbook 2009 and pilot study data

The researcher considered to choose representatives of local state-owned coal mines after accomplishing the above selection. A local state-owned coal mine means a coal mine which has been established and managed by the local government. Xinhua district as one of the most important components of Pingdingshan coal city was named a key national coal mining district by the former Ministry of Coal Industry in 1997 (*China Coal Industry Yearbook*, 2009). Xinhua district is administrated by Pingdingshan city council. Therefore, the research located the representative of LSOCM in Xinhua District. The researcher anonymized four local state-owned coal mines as coal mine B2, coal mine B3, coal mine B4 and coal mine B5 for ethical reasons.

Compared with four local state-owned coal mines, coal mine B2 is more suitable than coal mine B3, coal mine B4 and coal mine B5 in terms of ITT intensity, production, employees, development history and total assets (Table 4.4). Therefore, coal mine B2 has been chosen as representative of local state-owned coal mines.

Time	Name of Coal Mine	ITTI	Production(YR)	Employees	Total Assets(RMB)
1980	**Coal mine B2**	**5**	**350,000 tons**	**560**	**52.1 Million**
1985	Coal mine B3	3	320,000 tons	480	49.7 Million
1988	Coal mine B4	4	350,000 tons	542	51.2 Million
1990	Coal mine B5	5	350,000 tons	517	52.8 Million

Table 4.4 The 4 local state-owned coal mines located in Xinhua District

Source: China Coal Industry Yearbook 2009 and pilot study data

Most small-scale township and village coal mines were established from 1993 to 1997 (Han, 2009). The research selected ten small-scale township and village coal mines that were established in 1993 and located in Xinhua District. The researcher anonymized them as coal mine C2, coal mine C3, coal mine C4, coal mine C5, coal mine C6, coal mine C7, coal mine C8, coal mine C9, coal mine C10 and coal mine C11 for ethical reasons. Table 4.5 shows that three mines almost exhausted their resources, five small coal mines have been merged with large state-owned coal mines by the national mandatory policy that State Administration of Coal Mine Safety eliminates small-scale coal mines of backward production capacity (below 300 thousand tons) in three years; elimination methods rely on large state-owned coal mine merging with small-scale coal mines (Zhao, 2008). Currently, only two small coal mines (coal mine C5 and coal mine C7) kept the character of small-scale township and village coal mines. Comparing coal mine C5 with coal mine C7, coal mine C5 is more suitable than coal mine C7 in terms of ITT intensity. Therefore, coal mine C5 has been selected as the main case study.

Current Situation	Name	ITTI	Production	Employees	Total Assets (RMB)
Exhausted	Coal mine C2	1	60,000 tons	150	N/A
Merged	Coal mine C3	1	100,000 tons	180	N/A
Exhausted	Coal mine C4	1	50,000 tons	120	N/A
Operating	**Coal mine C5**	5	300,000 tons	320	21 Million
Merged	Coal mine C6	2	200,000 tons	240	N/A
Operating	Coal mine C7	3	310,000 tons	350	22 Million
Merged	Coal mine C8	3	280,000 tons	280	N/A
Merged	Coal mine C9	2	120,000 tons	200	N/A
Exhausted	Coal mine C10	3	250,000 tons	270	N/A
merged	Coal mine C11	2	180,000 tons	220	N/A

Table 4.5 The ten small-scale township and village coal mines located in Pingdingshan

Source: China Coal Industry Yearbook 2009 and pilot study data

Techniques for Data Collection

Following the qualitative approach, there are several methods to collect data. Yin claimed that case studies need to depend on a variety of sources rather than being limited to a single source of evidence (Yin, 2003, pp. 85-97). Ridder et al (2009, p. 141) also considered that case study indicates the flexibility of using qualitative and/or quantitative data by using various data collection approaches, for instance, archival analysis, observation and interviews.

Saunders et al (2008) considered archival analysis research makes use of records and documents as the main source of data. In the current research, enterprise websites, administrative records and documents, policy documents and newsletters, organisational charts and internal memos, presentation materials and publications are collected under the explicit data collection plan. These data are analyzed and used for triangulating the interview findings.

Saunders et al (2008) considered the observation as one research method is rewarding as it provides rich research data. The study adopted direct observation to complement the deficiency of the interview and archival analysis.

Yin (2003) highlighted that interview is one of the most important and useful sources of case study information. Yin (2003) also claimed that the semi-structured interview is used when the researcher wants to investigate deeply and comprehensively into the research topic, which allows the researcher to approach the full richness and variety of issues involved in the cases being studied, and may help to avoid the risk of being overly dependent on the interviewees. Corbetta (2003, p.270) stated that “the various topics are dealt with and the wordings of the questions are left to the interviewer’s discretion in the semi-structured interview”. Within each topic, the interviewer is able to conduct the conversation and asks the questions when appropriate. In other words, the use of semi-structured interview will produce deeper explanation and clarification if the answers are unclear. Owing to these advantages, this study adopted semi-structured interview as the main method to collect data in order to prompt further elaboration when necessary.

In brief, the case studies combined direct observation with semi-structured interview. The findings from the case studies can be used to provide insights into why many ITT projects have failed in the coal mining industry in Chinese context.

4.5.2 Survey

The survey data can be collected primarily by questionnaire on more than one case at a single point chronologically so as to obtain a body of quantitative or quantifiable data in association with more than two variables, which are to be examined to detect patterns of association (Bryman and Bell, 2011). The current study adopted inferential surveys and aimed to identify the factors affecting the effect of ITT in the Chinese coal mining industry.

Cooper and Schindler (2010) considered that several means can be used to secure information collection when the researcher has determined to use survey as an appropriate data collection approach. De Vaus (2002) stated that questionnaire is the most common method of collecting survey data. Sekaran and Bougie (2009) further pointed out that questionnaire survey is an efficient data collection mechanism when the researcher knows exactly what is required and how to measure the variables of interest. The current research adopted the self-completion questionnaire to collect primary data in order to test hypotheses, which is considered as one of the main instruments for gathering data in the social survey (Bryman and Bell, 2011), allowing respondents to answer the question by completing the questionnaire themselves.

Cooper and Schindler (2010) argued that in the last two decades of the 20th century and the first decade of the 21st century, a revolution has been under way in survey research. Driven by changing technology, the paper and pencil survey standard of the previous 60 years has been replaced by a new computerized standard. Han et al (2009) further argued the internet offers unique features – world-wide reach, around-the-clock availability, ability to collect real time feedback, access to low incidence populations and narrow topics, extremely low cost and fast speed (Schmidt, 1997; Schaefer and Dillman, 1998; Stanton, 1998; McCullough, 1998). Web-based survey is a special form of self-completion survey; it offers many features that are attractive from a survey quality perspective (Cooper and Schindler, 2010). Web surveys operate by inviting prospective respondents to visit a website at which the questionnaire can be found and completed online (Bryman and Bell, 2011). Table 4.6 shows the advantage and disadvantage of web-based survey.

Advantages of Web-based Survey	Disadvantages of Web-based Survey
• Short turnaround of results; results are tallied as participants complete surveys • Ability to attract participants who would not participate in another research project, including international participant • Ability to do numerous survey over time • Ability to use visual stimuli • Shortened turnaround from questionnaire draft to execution of survey • Accelerated data collection and streamlining of collection process • Fewer transcription errors • Increased geographic reach • Participants feel anonymous	• Recruiting the right sample is costly and time-consuming • While research is more compatible with numerous browsers, the technology is not perfect • It takes technical as well as research skill to field a web survey • Converting survey to the web can be expensive

Table 4.6 Advantages and disadvantages of web-based survey (Cooper and Schindler, 2010)

The objective of using the web-based survey was to investigate the main factors affecting ITT in the coal mining industry in the Chinese context. Owing to the response rates of web-based survey being generally low (Couper, 2000; Cole, 2005; Roster et al., 2007), in order to obtain sufficient information, data was collected across the country in order to cover most of the large state-owned coal mines. Therefore, the web-based survey is argued as the most appropriate approach in the current research.

Pilot Study

In order to improve the validity and reliability of the questionnaire, the questionnaire was conducted as a pilot survey firstly and then a main survey. This was done to ensure the validity and reliability in terms of the questions and answers. Foddy (1994, p.17) emphasized that “the question must be understood by the respondents in the way intended by the researcher and the answer given by the respondent must be understood by the researcher in the way intended by the respondent”. Therefore, the purpose of the pilot study is to discover if there were some ambiguities in the questions asked through giving certain pieces of advice and comments to respondents about the design of the questionnaire. The questionnaires of the English version have been sent to supervisors and other professors majoring in ITT, and the questionnaires of the Chinese version have been sent to 30 staff who have engaged in licensing in the Chinese coal mining industry. Their comments and advice have been adopted to revise ambiguous and overlapping questions in the questionnaire as well as improve the question wording.

Main Study

McNabb (2008) argued that researchers should use a number of techniques to achieve greater reliability of a sample study with minimum additional cost. Among the most important of these is the type of sampling method employed. Sekaran and Bougie (2009) made a distinction between the probability and non-probability sampling methods. The probability sample means that all the sample units are chosen at random, all of which have equal opportunity to be selected. The non-probability sample means that chance selection techniques are not used while selecting the samples. Tull and Hawkins (1993) recommended that the type of sampling techniques to be used for carrying out research should be based on the cost-versus-value principle. This was echoed by McNabb (2008), who considered that the method to be used should provide the greatest margin of value over cost. Fowler (2009) also pointed out that the choice of a sampling strategy should consider feasibility and cost as the basic criteria. Table 4.7 presents the sample selection procedures of this study.

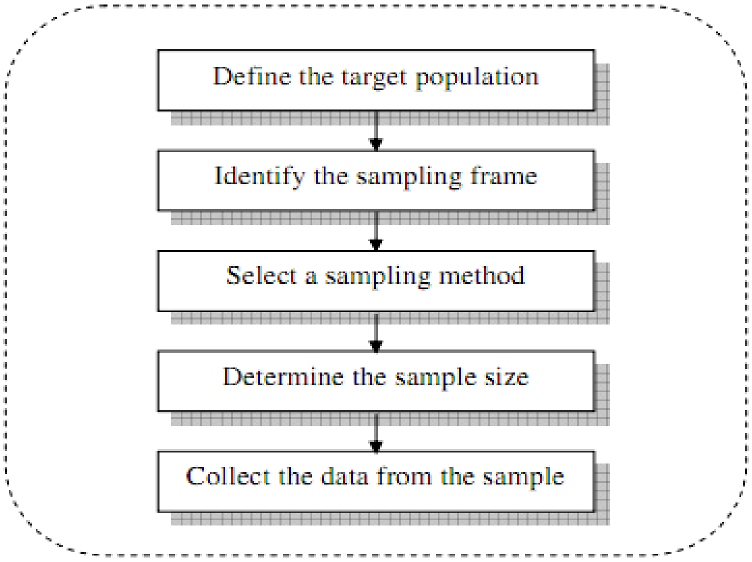


Table 4.7 Five-step procedure for drawing a sample

Source: Wilson (2006); Churchill and Iacobucci (2009)

In a study like this, it is considered that the study should have a comprehensive sample size which is representative of the general body of the coal mining industry in China. The population size is only drawn from large state-owned coal mines in China after the case studies. There are several reasons for this study to focus on large state-owned coal mines:

- The interview data have shown that small coal mines have to merge with state-owned coal mines according to national mandatory policy, which means that small coal mines will disappear after two or three years in the Chinese coal mining industry.
- From the extant literature, it was found that coal production of 13 coal bases (many large state-owned coal mines composed the 13 bases), had already reached 2.8 billion tons in 2010, which accounted for 87% of national coal output.
- The interview data demonstrated that both small coal mines and local state-owned coal mines have financial difficulty engaging in ITT.

In addition, the interview data further revealed that licensing was the most important channel of ITT for large state-owned coal mines to obtain new technology as the central government considered coal as a kind of strategy resource, which refers to national energy security. The central government limited FDI in coal mines in order to ensure national energy security, so it is impossible to obtain new technology through FDI and Joint Venture. Hence, this study focused on licensing based on the above mentioned reasons.

Moreover, the interview data revealed that safety and environmental problems are the main challenges that the coal mining industry is facing, such as gas explosions and methane emissions which cause the greenhouse effect. Large state-owned coal mines hope to cope with the challenges through ITT, such as transferring the US and Australia's coal-bed methane drainage technology. This study then focused on the licensing between large state-owned coal mines and foreign enterprises.

The target population of the current research was large state-owned coal mines' staffs who have engaged in ITT, which was obviously a very large and widely dispersed population.

Measures of the whole population were obviously not feasible based on practical consideration of time, expense and accessibility. Furthermore, the contact details of all relevant staff were not available, so it is extremely difficult to adopt the random sampling technique.

According to data of the China State Administration of Coal Mine Safety (2009), the Chinese coal mining industry had a total of 1051 large state-owned coal mines in 2009, all of which comprised 100 large state-owned coal enterprises in China. In other words, the Chinese coal mining industry had total of 100 large state-owned coal enterprises in 2009; the 1051 large state-owned coal mines are subsidiaries of 100 large state-owned coal enterprises (Wang, 2010). This means that each large state-owned coal enterprise has been comprised of about ten large state-owned coal mines. Owing to the response rates of web-based survey being generally low (Couper, 2000; Cole, 2005; Roster et al., 2007), this research decided to employ the questionnaire survey to cover the entire sample frame.

Due to good academic cooperation with the State Administration of Coal Mine Safety, the researcher obtained support from leaders of 100 large state-owned coal enterprises; they helped the researcher to forward links with the online questionnaire to relevant staff of their enterprises. Therefore, the current study combined the process of probability (group sampling) and non-probability sampling (snowball sampling) in order to achieve the greatest margin of value over cost.

4.6 Tools of Data Collection

The study used three tools for primary data collection in order to answer research questions comprehensively: observation, semi-structured interview, and self-completion questionnaire.

Observation and semi-structured interview were designed to supplement each other in order to investigate the necessity, channels and the process of ITT in the coal mining industry in the Chinese context. The self-completion questionnaire was designed to collect data in order to test hypotheses. In addition, observation, semi-structured interview, and self-completion questionnaire mutually supplement to identify the main factors that affect the effectiveness of ITT in the Chinese coal mining industry.

4.6.1 Observation

Direct observation occurs when a field visit is conducted during the case study (Tellis, 1997). It could be as simple as casual data collection activities, or formal protocols to measure and record behaviours. Observation is used for providing additional information on ITT being studied. The observation method was also used before the interview because it served as a prelude to the interviews, by guiding "us to some of the important questions we want to ask respondents" (Whyte and Whyte, 1984, p.129). The aim of observation is to make a record of ITT events in the coal mining industry, in order to understand the practical process of ITT. Moreover, the researcher also visited coal mines to understand the necessity and channel as well as process of ITT and the real situation of the coal mining industry.

Visiting Coal Mines

As mentioned previously, one aim of the current study is to understand the necessity and channel as well as process of ITT in the coal mining industry, visiting the coal mine therefore would provide valuable evidence for the current research. The General Manager of each coal mine arranged a miner to accompany the researcher, who acted as a normal miner visiting each coal mine, since Glesne and Peshkin (1992) recommended that the researcher should be as unobtrusive as wallpaper in the process of observation. The visit aimed to achieve the following research objectives:

- To understand the reasons that the coal mine adopted foreign technology rather than domestic technology;
- To identify the channel through which the coal mine obtained the foreign technology;
- To understand the process of ITT;
- To get an overall understanding of the effect of ITT;
- To find out the factors that may affect the effect of ITT.

The researcher always maintained an informal conversation with the working miners and technicians in the process of visiting in order to collect more relevant data. Owing to the fact that the researcher was not permitted to take any electrical equipment (e.g. recorder or camera) in underground mines during visits to comply with safety regulations, the information was gathered using written notes. Moreover, the researcher modified the semi-structured interview questions to accord with what was actually taking place and not with what was expected.

4.6.2 Semi-structured Interview

The previous section 4.5.1 discussed semi-structured interview as a tool of data collection of this study; this section will, however, elaborate on the entire process of semi-structured interview as the main body of discussion.

The semi-structured interview as a very important instrument of data collection was adopted in a number of ITT research studies in the management field, such as the works of MIT's Rebentisch (1994, 1995), Siachou and Ioannidis (2009) and Miller et al (2011). They all concluded that the use of semi-structured interview was an effective way of collecting detailed data while dealing with ITT. Semi-structured interviews were used in this study firstly to understand the necessity and channels as well as process of ITT in the coal mining industry in the Chinese context. Secondly, the use of the semi-structured interview helped to identify factors influencing the effect of ITT and, lastly, to find out the key ideas in the literature review which could support the generation of research hypotheses. These data were used to answer research sub-questions and to design the questionnaire as well as to check against the evidence collected from the questionnaire. Moreover, the current study followed five successive steps to conduct semi-structured interviews, as discussed in the following paragraphs: developing interview questions, identifying key informants, approaching participants, conducting the semi-structured interview and data transcription.

Developing Interview Questions

A list of questions on fairly specific topics to be covered is needed when conducting a semi-structured interview, which is often referred to as an interview guide (Bryman and Bell, 2007); however the interviewee has a great deal of ways to provide responses. King and Horrocks (2009) stressed that an appropriate and comprehensive interview guide is significant for conducting semi-structured interviews as it allows the researcher to probe and to elicit extensive responses and hence reveal hidden details and provide new information to an enquiry (Bryman and Bell, 2007). Further, they also stressed that in deciding how comprehensive to make the interview guide, the researcher should reflect on the objectives and methodological position of the research (King and Horrocks, 2009). With regard to this study, it aimed to answer the main research question of the main factors affecting the effect of ITT in the coal mining industry in the Chinese context. The semi-structured interview in the methodological position of this study is the exploratory approach. Therefore, the interview protocol followed the explicit research objective and methodological position of this study in order to lay more focus on the research issues. Owing to the interviewees having undertaken different roles in an organisation, the interview questions were tailored to suit the interviewees. Moreover, the nature of the semi-structured interview also allowed opportunities for newly emerged issues during the process of interview (Gubrium and Holstein, 2001).

The design of the interview questions first concerned the organisational background, history, production capacities, technological equipment and market position of the coal mine as well as the challenges faced and possible solutions to the problems. This was undertaken first by doing background reading and by searching the relevant documentation from websites of governments and enterprises, speeches by governors and managers, and accessible publications as it is important to gather the organisational background information and thereby a better understanding of the context in which the coal mine engages in ITT.

In addition, it was also important to understand the necessity and channel as well as process of ITT. This involved questions about foreign technology (e.g. coal-bed methane drainage technology) as a solution to cope with challenges (e.g. gas explosions), working mechanisms and sources of foreign technology, the channel and process of acquisition of foreign technology, and the effect of ITT. Finally, specific questions were raised to identify the main factors affecting the effect of ITT during the interviews.

Identifying Key Informants

The researcher asked the respondents in this study to propose their own insights into certain occurrences and used this approach as the basis to elicit more added questions. In this situation, as Yin (1989) suggested, the interviewees became more of a ’key informant’ as opposed to a ’respondent’. Key informants can influence the outcome of a case study because they provide insight and can also suggest sources of corroboratory evidence (Yin, 1989). Gummesson (1991) and Patton (1990) further considered that the aim of purposive sampling is to select the key informants whose knowledge and expertise are relevant to the issues being investigated. In fulfilling this aim, 18 individuals were drawn from three coal mines, all of whom had professional knowledge and working experience related to ITT. The rationale for selecting the coal mines has been stated in the previous section 4.5.1

The key informants have been chosen based on the research objectives and the role of their positions. Owing to this research being to investigate ITT of the coal mining industry from the management perspective, the interview targeted key informants whose role was most relevant to ITT. At the same time, key informants were both managers and ITT elites in the coal mine. According to the organisation structure of coal mines, ITT projects of a coal mine have been managed by the general manager, general engineer, deputy general manager (mainly responsible for technology management), directors of the technical department and mining department as well as the captain of the miners team. The researcher drafted an initial list of key informants (positions in large state-owned coal mines, local state-owned coal mines, small-scale township and village coal mines). The list was then sent to one of the researcher’s personal contacts who is an academician in the research field of CAE (Chinese Academy of Engineering) for comments. The final list of key informants was tested through the pilot case studies. The operational list of key informants is shown in Table 4.8 below.

	Job Title	**Type of Coal Mine**
1.	General Manager	Key (large) state-owned coal mine
2.	General Manager	Local state-owned coal mine

3.	General Manager	Small-scale township and village coal mine
4.	General Engineer	Key (large) state-owned coal mine
5.	General Engineer	Local state-owned coal mine
6.	General Engineer	Small-scale township and village coal mine
7.	Deputy General Manager	Key (large) state-owned coal mine
8.	Deputy General Manager	Local state-owned coal mine
9.	Deputy General Manager	Small-scale township and village coal mine
10.	Director of Technical Department	Key (large) state-owned coal mine
11.	Director of Technical Department	Local state-owned coal mine
12.	Director of Technical Department	Small-scale township and village coal mine
13.	Director of Mining Department	Key (large) state-owned coal mine
14.	Director of Mining Department	Local state-owned coal mine
15.	Director of Mining Department	Small-scale township and village coal mine
16.	Captain of Miners Team	Key (large) state-owned coal mine
17.	Captain of Miners Team	Local state-owned coal mine
18.	Captain of Miners Team	Small-scale township and village coal mine

Table 4.8 Key informants of semi-structured Interview.

Approaching Participants

Saunders et al (2008) considered that ability of the researcher to obtain interview data will rely on the researcher gaining access to the targeted organisation. The first level of access is physical access or entry (Gummesson, 2000). Saunders et al (2008) further pointed out that gaining physical access is not easy. There were numerous students requesting access to the coal mines and it was impossible to grant them all entrance. However, a 'gatekeeper' is very necessary if the researcher hopes to gain access to all informants in this situation (Saunders et al., 2008, p. 188). According to the unique Chinese political culture, the ’gatekeeper’ should either have a high position in politics or a remarkable reputation in academia. The researcher therefore sought help from one of his personal relations at the State Administration of Coal Mine Safety, who is a top manager in the ministry. Moreover, to avoid the political pressure that may arise, the researcher suggested the ’gatekeeper (the top leader)’ to contact the Dean of the local coal research institute who acted as the ’secondary gatekeeper’. The secondary gatekeeper contacted all key informants so that the researcher was able to gain access to all targeted key informants more easily.

Conducting the Semi-structured Interview

Johnson (2001) stressed the issue of avoiding misunderstanding caused by language barriers while conducting the interview. Owing to all the interviewees involved in this study and the researcher all being Chinese, the interviews were conducted in Chinese rather than English in order to build an intimate atmosphere between the interviewees and the researcher. Moreover, the researcher also tried avoid any potential political pressure, so the overall order of the interviews was organised deliberately, that is, in each coal mine, the interview started first with the general manager and ended with the captain of the miners team. The interview venue was decided by each interviewee – most of interviews took place in their offices to avoid interruption. Only two interviews took place in the reception room of the coal mine based on interviewees’ suggestions. Each interview was conducted as a formal face-to-face and sit-down meeting in order to achieve a more controlled environment with more in-depth conversation.

Figure 4.3 shows the steps of each interview. As shown, the researcher set up an appointment with each interviewee by phone. The researcher also sent the interview questions to each interviewee by mobile phone SMS (short message service) the day before the formal interview was conducted. The researcher spent about ten minutes brief introducing the research purpose and establishing a rapport with the interviewees for ’icebreaking’ before the formal interview. Terms of confidentiality were addressed to each interviewee. During the process of the interview, the researcher tried to make informants understood that this was purely academic support requested by a friend. Moreover, the researcher sufficiently prepared before conducting each interview in order to obtain as much useful data as possible from the interviewees. Although some interview questions were a sensitive topic for interviewees, the researcher utilized his own knowledge to provoke the interest of the interviewees, who were therefore willing to answer the questions truthfully. The researcher also noticed and made a record of the non-verbal expression of each interviewee by notes during interview. Each interview lasted about one hour. The researcher and most of the interviewees became friends through the interview; the friendship has helped the researcher to easily gain copies of documents that were not available elsewhere, some of which were highly confidential.

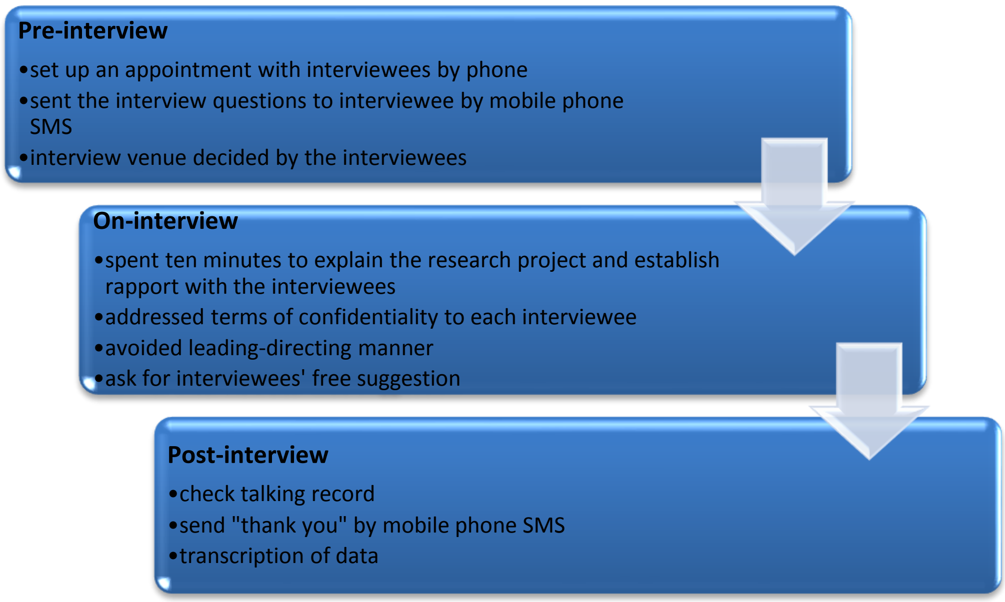


Figure 4.3 The procedure of conducting the semi-structured interview

As mentioned, some of the interview questions tended to be sensitive topics, such as issues relating to safety problems and gas explosions in the coal mining industry; all the interviewees avoided being recorded during the process of the interview. Hence, during the interview, full notes were written down as much as possible in order to keep a record of the information provided by the informants. However, three general managers of coal mines were persuaded and the researcher was allowed to record the whole talking process with a recording pen. Miles and Huberman (1994) firmly recommend early analysis where the researcher is able to think about the data that has already been collected back and forth and to develop new strategies for collecting more new useful data. “It can be a healthy corrective for built-in blind spots” (Miles and Huberman, 1994. p.50). Therefore, after each interview, while the memory was still fresh, the researcher summarized notes and the points that had not been captured during the interviewing and thought about ways to capture the points in the next interview, as well as questions which had not been directly answered and whether the interviewer misunderstood the question and ways to improve the manner of the question in the next interview; any new point mentioned by the interviewer and whether they can be arisen as new themes were all summarized and seriously considered by the researcher. Finally, the researcher asked each interviewee to check the full notes in order to ensure the interview data was properly recorded when each interview was completed.

Data Transcription

Saunders et al (2008) stated that it is not only necessary to make a record of exactly what the interviewees have said, but also to provide indications of the tone in which it was said as well as the non-verbal behaviours during the data transcribing process. Therefore, after the interview, the researcher first tried his utmost to become familiarized with the interview data and then transcribed and translated the interview data from Mandarin into English when the interviewer’s memory was still fresh. Hofstede (2003, p. 21) stated that “language is not a neutral vehicle; our thinking is affected by the categories and words available in our language". The researcher tried to find the corresponding words in English or the apparent equivalent words which expressed the meaning intended by the researcher. The tones of the interviewees were also considered in the process of transcribing. In this situation, the researcher had to translate the words according to the research context, otherwise the translation would have had a number of inaccuracies. In order to reduce the inaccuracy of translation, the researcher invited a bilingual expert who is familiar with the content and context of the document. The expert corrected a number of errors of translation and improved the accuracy of the translation in order to increase the validity of this research. Further, peer review was adopted during the transcribing stage. The transcript of the semi-structured interviews was reviewed by supervisors and Chinese professors of UK Universities in the relevant field as it is unlikely that the researcher can spot every mistake.

4.6.3 Self-completion Questionnaire

In the field of business and management research, questionnaires are used mostly within the survey approach (Saunders et al., 2008). Questionnaires can be divided into two types: telephone questionnaires and self-completion questionnaires (Saunders et al., 2008). Owing to this study's plans to send 1,000 questionnaires, there is currently no reliable database to obtain telephone numbers of the 1,000 respondents. Hence, this study adopted the self-completion questionnaire which needs respondents to read each question themselves and answer the questions themselves (Bryman and Bell, 2011). Saunders et al (2008) considered three types of self-completion questionnaires: internet and intranet-mediated, postal, delivery and collection. Saunders et al (2008) clearly stated that the kind of self-questionnaire to be adopted in research will mainly rely on the researcher's resources, such as time available to complete the data collection, and financial implications of data collection. Considering the three types of questionnaire, this study adopted the internet-mediated questionnaires based on researcher's resources and attributes of the questionnaire, as shown in Table 4.9 below.

Attributes of Internet- and Intranet-mediated Questionnaire	
Population's characteristics for which suitable	Computer-literate individuals who can be contact by email or internet
Confidence that right person has responded	High if using email
Likelihood of contamination or distortion of respondent's answer	Low
Size of sample	Large, can be geographically dispersed
Likely response rate	Variable, 30% reasonable within organizations/via intranet, 11% or lower using internet
Feasible length of questionnaire	Conflicting advice; however, fewer "screens" probably better
Suitable types of question	Closed questions but not too complex, complicated sequencing fine if uses IT, must be of interest to respondent
Time taken to complete collection	2-6 weeks from distribution (dependent on number of follow-ups)
Main financial resource implications	Web page design, although automated expert systems providers are reducing this dramatically
Data input	Usually automated

Table 4.9 Attributes of internet-mediated questionnaire

Source: Saunders et al (2008, p.364)

The purpose of the questionnaire is to provide a quantifiable level of response to test hypotheses in order to identify implications of relationships that could explain the phenomenon of ITT within different variables. The rationale for using an internet-mediated questionnaire instead of a paper-based questionnaire is explained as follows:

First of all, there are a large number of commercial online survey providers who provide various templates to carry out all kinds of survey requirements. They also help researchers to automatically analyze and tabulate the primary data, such as Askform and Zoomerang.

Secondly, the internet-mediated questionnaire reduces the time and finance budget more than paper-based questionnaires, for example, the postal questionnaire. Moreover, the internet-mediated questionnaire utilizes hyperlinks and Javascript to present a visual example for respondents.

Thirdly, the response data is displayed in numerical and graphic format when the internet-mediated questionnaire has been submitted. Moreover, the internet-mediated questionnaire also automatically reminds and follows up non-respondents.

Fourthly, the selected Chinese commercial internet survey provider can record and update the progress of answering survey questions for each respondent based on their IP address. The IP can locate participants' latitude/longitude in order to identify the participator by Google map to know the location of the large state-owned coal mine.

Moreover, respondents who did not complete the questionnaire can restart the questionnaire at the point where they withdrew last time rather than at the beginning of the questionnaire. Participation in the survey was completely voluntary and respondents could withdraw from the survey at any point.

Dillman (2007) pointed out that the researcher needed to consider and avoid the limitations of the web-based survey before designing and conducting it. This survey targeted the managers and technicians of the coal mining industry who were engaged in licensing. The data of the semi-structured interviews revealed that coal enterprises have provided each manager and technician with a computer with connection to the internet, indicating that web-based survey in the current research is suitable and it is suitable to create the sample frame. In addition, the researcher also considered that although they have an internet connection, not all potential respondents are equally computer literate. Hence the internet-mediated questionnaire has been designed in a simple format, where a large number of questions gave relevant examples to be explained and instructed in order to facilitate respondents in answering the questions. Moreover, the researcher also considered that the respondent involved may have different computer settings, and each computer may display a different screen configuration. Thus, this study was platform independent by using a commercial online survey provider to ensure each computer rendered it in the same format.

Moreover, a five-point Likert scale has been adopted in the questionnaire for the following reasons:

First of all, developed by Rensis Likert, the Likert scale is often adopted by business researchers and is extremely popular for measuring attitudes because the method is simple to administer (Zikmund, 2003). With the Likert scale, the respondents respond by expressing how strongly they agree or disagree with carefully constructed statements, ranging from strongly agree to strongly disagree toward the attitudinal object. In this study, participants chose from five alternatives where '1' indicated strongly agree, '2'=agree, '3'=neutral, '4'=disagree, and '5'=strongly disagree.

The questionnaires used in the study had statements representing different factors that affected the effect of ITT. Reading from the scale provided by the respondents, the researcher could identify the factors that affected the effect of ITT from the most to the least as well as the causal relationships of the variables involved and made predications and implications.

Development of the Questionnaire

Oppenheim (2000) stated that it is far harder to design a good questionnaire than one imagines. It is of vital importance to ensure the data collected should be precise and will target the research questions to be answered and thereby achieve the research aims (Saunders et al., 2008). Table 4.10 below presents the steps of questionnaire development for this study.

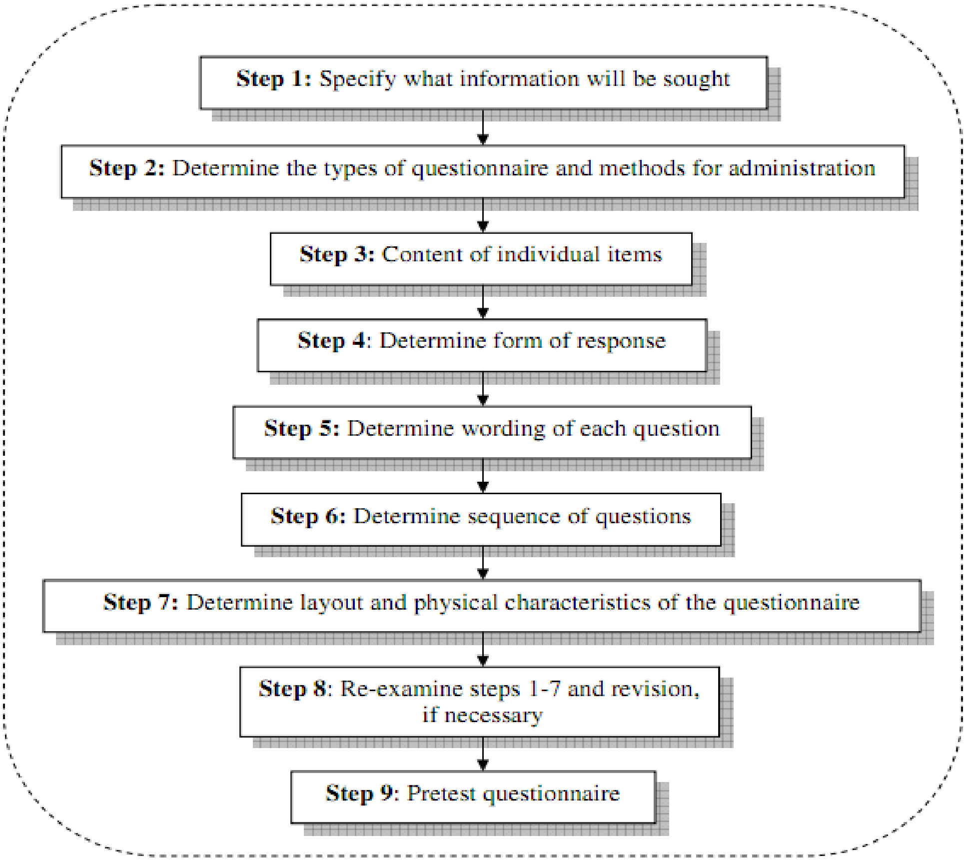


Table 4.10 Steps of Questionnaire Development

Source: Churchill and Iacobucci (2009, p. 205)

The purpose of the questionnaire is to test hypotheses and to determine the causal relationships between the variables generated from the interview data. The types of questionnaire adopted internet-mediated questionnaire whereas the content of individual items have been drawn from the previous literature and case study's findings; each item was found to be related to the effect of ITT. The form of response adopted closed questions with

Likert scale as well as multi-choice questions. The research tried to avoid leading questions, implicit assumptions and generalizations questions. The sequence of questions started from simple closed questions and proceeded to more probing opened ones so that the participants would feel comfortable to complete them. The exquisite questionnaire template can be selected by the commercial internet survey provider, the template used hyperlinks or Javascripts, meaning that relevant examples, explanations and instructions for completing were fully provided to the respondents. A cover letter was designed to provide an overview of the research and some explanation of the key terminology was also provided.

The internet-mediated questionnaire consisted of four sections. This first section was developed to collect the background information of respondents, including participants' experience in licensing, transferee's size and transferor's performance. Background information is considered valuable by recent research as relevant factors influencing the effect of ITT. In particular, transferee's size and transferor's performance are among the most investigated factors (Saad, 2003; Cohen, 2003; Li-hua, 2004) and it was concluded from previous literature that they have a significant relationship with the effect of ITT. Other variables were included in the questionnaire as they were generated from the case studies' findings. The research therefore considers that these variables may affect the effect of ITT. The effect of ITT has been designed as a dependent variable.

The second section covered aspects of government. These questions aimed to measure how the government as a dimension affects the effect of ITT (Bozeman, 2000; Chen et al., 2003; Zhao, 2007). The section included ten items from different aspects of government, such as policy, strategy, regulation and system.

The third section covered aspects of organisation. These questions were designed to measure organisational technology management, individual, team, organisational and inter-organisational learning as five dimensions affecting the effectiveness of ITT. This part of the questionnaire included 40 items, among which 12 questions measured organisational technology management including organisational strategy, structure, human resources, internal environment and finance as well as training, and 28 questions measured individual learning, team learning, organisational learning and inter-organisation learning.

The selected 54 items were generated from the case studies' findings and the extant literature, all of which were found to be related directly to the effect of ITT, therefore, they were designed as independent variables. Respondents were asked to rate how much they agreed with certain statements on a five-point Likert scale.

Open questions were designed in the fourth section of the questionnaire. The inclusion of the open-ended questions gave respondents opportunities to provide suggestions freely. It also provided participants with a chance to state anything that was vital to affect the effect of ITT but which had not been mentioned in the questionnaire. Even though participants may have state little information, the open questions may result in unexpected and potentially important information.

In order to improve the validity and reliability of the questionnaire, the questionnaire was conducted as a pilot survey firstly and then a main survey. This was done to ensure the validity and reliability in terms of the questions and answers.

4.7 Data Analysis

Analysis of Observation Data

According to Bryman and Bell (2007), observation data typically take the form of a large corpus of unstructured textual material, indicating they are not straightforward to analyze. The following procedure presents the analysis process of the field notes and journal of the observation. First of all, the researcher converted the rough field notes and journal entries into an edited record which could be clearly understood. The researcher also added his own thoughts and reflections in the edited record while the rough field notes and journal entries were converted, but it should be noted that the researcher distinguished his own interpretation and speculation with factual field notes and journal entries in the edited record. Secondly, the researcher labeled the significant remarks and key words in the edited record as reference, indicating who was involved, the date and time, the context, the circumstances leading to the data collection and the possible implications for this study. The researcher recorded the references on a pro-forma summary table; this step meant the key words could be properly referenced in further research. Thirdly, Flick (1998, p.179) defined coding as: "the constant comparison of phenomena, case, concepts and so on and the formulation of questions which are addressed to the text". Wilson (2010) considered two approaches to code data: emergent coding (inductive) and priori coding (deductive). In this study, the categories have been developed through examining collected data rather than prior determining categories. The researcher coded data and allocated a specific code to each concept. The code allowed the researcher to store the data, retrieve it and reorganise it in a variety of ways. Finally, the findings of the data analysis guided the researcher to ask the more important questions in semi-structured interviews.

Analysis of Interview Data

According to Bryman and Bell (2007), ground theory has become the most widely used framework for analyzing qualitative data. The analysis of interview data adopted ground theory as a method of analyzing data rather than other methods based on the following justifications:

The current study developed the theoretical framework to explain the phenomenon under this study based on existing theories that have been developed based on other contexts or industries rather than the Chinese coal mining industry. This means the theoretical framework may not be appropriate to the Chinese coal mining industry, hence, the researcher analyzed the interview data under no preconceived substantial theoretical framework in order to evaluate and compare existing theories with the research findings. Collis and Hussey (2009) argued that grounded theory as a method is widely employed to analyse qualitative data where there is no preconceived theoretical framework. Wilson (2010) further stated that grounded theory is a method in which the theory is developed from the data rather than theory being applied at the outset; it is very much an inductive approach. Figure 4.4 presents the stages in grounded theory (Wilson, 2010, p.264). The researcher followed grounded procedures to analyze the interview data.

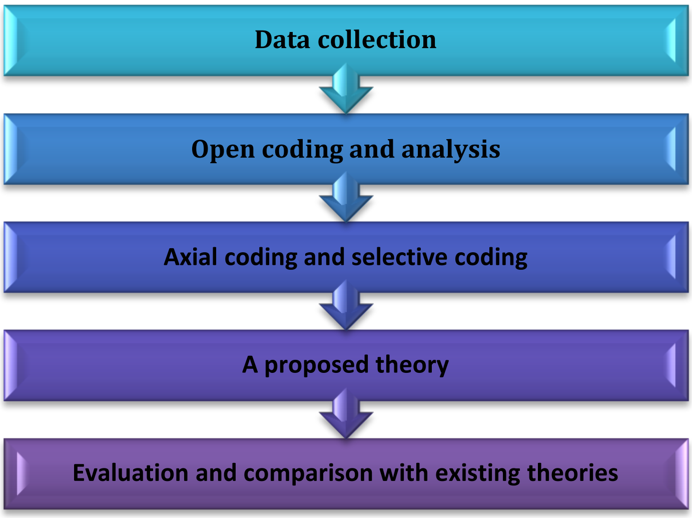


Figure 4.4 Stages in grounded theory (Wilson, 2010, p.264)

First of all, the researcher started to analyze the data by reading the interview transcripts and looked over the notes made during the data collection stage. The reading and rereading of the transcripts helped the researcher to discover and create the codes from the interpretation of data. ”Codes are used to retrieve and organize the chunks mentioned earlier (Miles and Huberman, 1994, p.57)”. The codes enabled the data to be separated, compiled and organised in order to quickly find, pull out, and cluster the segments relating to the research question and hypothesis. In addition, the researcher broke down and labeled the individual elements of information in order to make the data more easily recognizable and less complicated to manage.

These codes were then organised into a pattern of concepts and categories, together with their properties. The researcher also classified the different elements into distinct concepts and grouped similar concepts into categories and sub-categories. The properties of each category of concepts were defined along a continuum.

Secondly, the researcher connected categories and sub-categories together on a more conceptual level. The data was reconstructed and rebuilt into various patterns with the intention of revealing links and relationships, including the process of developing the properties of concepts and category of concepts, and linking them at the dimensional level. Furthermore, the researcher constructed mini-theories about the relationships that might exist within the data and which needed to be verified.

Thirdly, the researcher identified and selected the core category which appeared to be the central phenomenon, around which all other categories are based, and then systematically related core category to other categories, validated these relationships and filled in categories that needed further refinement. This process enabled themes to be generated which could then be ’grounded’ by referring back to the original data.

Analysis of Questionnaire Data

This study received 629 questionnaires in total through the web-based survey. 5 questionnaires were uncompleted, with some missing answers and blank pages, 9 were not valid because the respondents had not engaged in the licensing, 27 questionnaires were from the transferors and 5 questionnaires were from others, since this study focuses mainly on the transferee’s standpoint rather than the transferor to investigate factors that affect the effective of ITT. Therefore, 46 questionnaires were considered to be out of the scope for regression analysis, and 583 questionnaires were valid for further quantitative analysis.

The commercial service provider of the web-based questionnaire provided the author online data analysis service when the author paid the fee. The current research also used the following online data analysis services:

Line charts were created automatically in real-time while respondents submitted the questionnaires.

All respondents' responses were summarized and displayed on one page while they submitted the questionnaires.

Basic frequency calculations and multiple choice calculations were included in summary and individual question results.

SPSS command files were created and directly imported data into SPSS.

Word cloud (tag cloud) presented a visual representation of text data. The service is useful for quickly perceiving the most prominent terms and for locating a term to determine its relative prominence.

Bryman and Bell (2011) pointed out one of the biggest mistakes that researchers make about quantitative data analysis is social researchers do not know how to analyze the data prior to the data collection because quantitative data analysis looks like a distinct phase that comes after the data collection. In order to avoid the mistake, the researcher was fully aware of the data analysis techniques before designing the self-completion questionnaire.

Bryman and Bell (2011) consider that SPSS is possibly the most widely used computer software for analysing quantitative data. This study adopted IBM SPSS 20 (IBM Statistical Package for Social Science 20 version) to analyse quantitative data in order to test 6 hypotheses. The detailed analysis results have been reported in Chapter 6. The following are several reasons for choosing IBM SPSS 20 as an analysis tool for questionnaire data.

Firstly, SPSS helped the author to reduce the long hours spent in working out scores, carrying out involved calculations, and making those inevitable mistakes that so frequently occur

(Bryman and Cramer, 2011). Secondly, SPSS is easy to use and is able to do a wide range of analyses from simple descriptive statistics to all kinds of complex multivariate analyses, such as descriptive statistics, multivariate analysis, correlation analysis and multiple regressions (Stevens, 2007, p.15). With regard to this study, descriptive, correlation and regression analysis techniques will be used to identify factors that affect the effectiveness of ITT.

First of all, the author performed the descriptive statistical analysis before conducting correlation analysis in order to summarise large quantities of data by a few numbers and discover the most important numerical features in the data.

Secondly, the researcher performed correlation analysis before performing regression analysis. Pearson Correlation analysis has been used to measure the association between affecting factors and ITT effect. A Correlation Coefficient (r) is a statistic used for measuring the strength of a supposed linear association between two variables. The Pearson Correlation Coefficient is the most common Correlation Coefficient, which was mainly used to measure the relationship between the dependent and independent variables. In addition, frequency, mean and standard deviations were used for further analysis (Bryman and Cramer, 2011).

However, a correlation between two variables does not demonstrate a causal relationship between the two variables, no matter how strong it is. Correlation is merely a measure of the variables' statistical association, not of their causal relationship. Inferring a causal relationship between two variables on the basis of a correlation is a common and fundamental error (Bryman and Cramer, 2011).

If two variables are highly correlated, it then becomes possible to predict the value of the dependent variable from the value of the independent variable by using regression techniques. Since this study adopted the five-point Likert scale to measure the rate of dependent variable and independent variable, how much respondents agreed with certain statements, the author argues that linear regression can be adopted in analysis of questionnaire data if there is a linear relationship between dependent variable and independent variable. Worster (2007, p.111) stated that "To be suitable for linear regression, the outcome of interest must be a continuous variable". Swanson and Holton (1997, p.73) argued "research data is that obtained from survey data asking for response on a Likert scale (1-4; 1-5; 1-9). Statistically, this data can be handled as continuous data". In addition, the UK Higher Education Academy (2012) conducts the National Student Survey (NSS), which is a survey of final-year undergraduates. The National Student Survey is based to a significant extent on the Course Experience Questionnaire which has been analyzed by linear regression; the dependent variable of the questionnaire is a five-point Likert scale, which was treated as a continuous variable. The author understands that the type of data cannot only be analysed by linear regression, but also can be analysed by other methods. However, the author argues that linear regression was selected for the simplicity of the output and interpretation of the regression coefficients.

Thirdly, the author performed scatter plots before performing linear regression analysis in order to see if there are linear relationships between dependent variable and independent variables. Scatter plots also present the nature of the associations between dependent variable and independent variables.

Linear regression analysis is a tool with the following important applications (Carver and Nash, 2011):

- It is a way of testing hypotheses concerning the relationship between dependent variable and independent variable.

- It is a way of estimating the specific nature of such a relationship. Regression helps researchers to understand how dependent variable and independent variable are related.
- It assists the researchers to predict the value of one variable if the researcher knows or can estimate the other variable.

Since this study needs to test hypotheses concerning the relationship between ITT effects and six dimensions, linear regression analysis has been performed. In simple linear regression, the value of one variable (X, affecting factors) is used to predict the value of the other variable (Y, ITT effect) by means of a simple linear mathematical function, the regression equation, which quantifies the straight-line relationship between the two variables (Bryman and Cramer, 2011).

The simple linear regression equation is the same as the equation for any straight line:

Expected value of $Y = a + bX + e$

a: is a constant, known as the "intercept constant" because it is the point where the Y axis is intercepted by the regression line.

b: is the slope of the regression line, known as the regression coefficient.

y=dependent variable; it is the ITT effect.

x=independent variable; it is the affecting factor.

Once the value of a and b have been established, the expected value of Y can be predicted by any given value of X.

In the analysis process of the current research, the author combines the questions measuring the same theoretical construct into a single construct measure. For example, in the government's perspective, the author combines ten questions into a single score by taking their average. Before doing that, the author conducts a scale reliability analysis to determine if they all fit within the same constructs. In addition, the author runs multiple regression analysis with all constructs of interest entered together in the single model after finishing single measures for each construct. Moreover, the author also runs a stepwise analysis entering a set of control variables in order to assess their incremental effect.

4.8 Validity and Reliability

There are four tests common to all social science methods: "construct validity, internal validity, external validity and reliability" (Kidder and Judd, 1986, pp. 26-29). Validity and reliability are two of the most prominent criteria to evaluate business and management research. According to Bryman and Bell (2011), validity is concerned with the integrity of the conclusions that are generated from a piece of research while reliability is concerned with the question of whether the results of a study are repeatable. This study, however, adopted methodological triangulation to raise the level of validity and reliability. Details will be illustrated below.

4.8.1 Validity

Validity is the extent to which the research findings accurately represent what is really happening in the situation (Collis and Hussey, 2009; Cooper and Schindler, 2010). The validity of qualitative research relies on the objectivity of the researcher; it refers to the honesty, depth, richness and scope of the data achieved, the participants approached, and the extent of triangulation. The validity of quantitative research refers to the careful sampling, appropriate methods and statistical treatments of the data.

While conducting this study, the researcher tried his utmost to eradicate possible bias to ensure the truth of the results. Methodological triangulation was employed, as Ghauri and Grønhaug (2005) suggested that it is particular useful in business research to examine methods bias; convergence of results gathered through these different methods will facilitate the validity of research results. Before the start of data collection, each data collection method was carefully considered and was discussed with supervisors and then tested through pilot study.

Observation, semi-structured interview and self-completion questionnaire have been adopted in the current research to study the main factors affecting the effect of ITT from different perspectives, which help the researcher to achieve a more comprehensive outcome and enhance the validity of data. In addition, the researcher carefully chose the interviewees based on advice given by an academician in Chinese Academy of Engineering, who is also a leading researcher in this field. Each interview used the native language (Mandarin) in order to avoid misunderstanding. Each transcription was sent to interviewees and their feedback was received in order to confirm no misunderstandings during the interview process. Moreover, interpretation will be drawn from triangulated data sources in order to enhance the validity of data.

Internal Validity

Internal validity dealt with the question of whether a conclusion that incorporates a causal relationship between two or more variables holds water (Bryman and Bell, 2011). However, Ghauri and Grønhaug (2005) pointed out that a correlation between two variables does not necessarily mean a causal relationship as the correlation coefficient does not tell researchers anything about direction, or whether the relationship is influenced by other factors. Therefore, this study adopted regression analysis to determine whether there are causal relationships between affecting factors and ITT effect.

Wilson (2010) stated that there are two main types of internal validity: content and construct validity. Within each type, content validity includes face validity and sampling validity. First, face validity concerns the extent to which an instrument measures what it is supposed to measure (Wilson, 2010). In order to ensure the face validity of this study, the researcher sent the interview questions and questionnaire to supervisors and other Chinese professors majoring in ITT, who viewed the questions prior and give their comments in order to compile a final version. The sampling validity ensures that researcher's measure includes all areas within the nature of research (Wilson, 2010). In order to ensure sampling validity of this study, measurement of the research did not take a narrow view, but examined most of the dimensions that affect the effect of ITT.

Construct validity requires that the researchers establish "correct operational measures for the concepts being studied" (Kidder and Judd, 1986, p. 26). In order to ensure construct validity of this study, the researcher took rigorous steps. First of all, the pilot study has been designed to pilot the methods of data collection; secondly, the researcher used data triangulation to present multiple sources of evidence in order to provide multiple measures of the same phenomenon.

External Validity

External validity is concerned with the question of whether the result of a study is generalisable or transferable to the wider population, cases, settings, times or situations

(Bryman and Bell, 2011). In other words, external validity is concerned with whether the measure used in the research will produce the same results when applied to the same subjects by different researchers. Generalisability is sometimes referred to as external validity (Saunders et al., 2008, p.158). Coldwell and Herbst (2004) provided two main approaches to how researchers provide evidence for a generalization: sampling model and proximal similarity model. This study employed the questionnaire survey to cover the entire sample frame in order to ensure external validity. The researcher also thought about different contexts and developed the proximal similarity framework about which contexts are more like this research and which are less so. Therefore, the researcher can generalize the results of this study to the licensing of Chinese large state-owned coal mines.

4.8.2 Reliability

Reliability is concerned with the question of whether the results of a study are repeatable (Bryman and Bell, 2011). Although reliability is important to research, it is not sufficient unless it is combined with validity (Wilson, 2010). In order to ensure reliability of this study, the researcher designed a set of rigorous steps. First of all, this study adopted a systematic and rigorous research strategy for research design, data collection, analysis and interpretation of findings. Second, it collected sufficient evidence in order to draw substantial conclusions that could stand up to scrutiny. Finally, bias was reduced by data triangulation and validity of the data analysis method.

4.9 Ethical Issues

Ethical issues arise at various stages in business and management research. The principal concern with ethical issues arises in relations between researchers and research participants in the course of an investigation (Bryman and Bell, 2011). When conducting business and management research, researchers should be professional and responsible, using an appropriate means of data collection, and involve informed consent, carefully control deception, and be carefully interpreted (Russ-Eft et al., 1999). This study obeyed the following ethical principles when it was carried out. First of all, the researcher obtained informed consent from potential research participants and minimized the risk of harm to participants. For example, the researcher explained in detail the objective of this study and the importance of their participation before they participated in this study. Secondly, the anonymity and confidentiality of each participant were protected, for instance, in the process of data collection, the researcher declared the methods of storing data to each participant and that all collected data would only be used for the purpose of study. Except for the researcher and the supervisor team, others will not able to access to these data. The researcher will not record the process of interview unless the interviewee permitted it. Finally, the researcher avoided using deceptive practices and gave participants the right to withdraw from this study. Each participant was informed that this research is completely voluntary, if they felt uncomfortable at any time when they participated in this study, they had the right to withdraw at any point.

4.10 Conclusion

This chapter presented in detail the philosophical and methodological issues in order to provide substantial understanding of the process of the current research and the methods used. The methodological consideration of this study also provided substantial underpinning to the implementation of the empirical study. In addition, the rationale for combining the case studies and the survey as research strategies of this study has also been elaborated. This chapter also discussed and explained the methods and justifications for conducting the case studies and survey as well as the techniques adopted in collection and analysis of data.

In brief, the design of this study was based on the nature of the research objectives and questions. Direct observation, semi-structured interview, and self-completion questionnaire have been adopted in the current study to ensure that the research objectives can be fulfilled. The researcher evaluated the potential criticisms of each selected method to provide a good understanding of the advantages and disadvantages of each method in order to improve the overall design of this study. Finally, the process of implementing the case studies and survey has been elaborated in order to present how the process was carefully managed to ensure the validity and reliability of this study.

Chapter Five – Presentation of Pilot Case Studies

5.1 Introduction

Having reviewed literature concerning ITT and elaborated the research design in detail, this chapter will present and discuss findings obtained from pilot case studies in order to provide a preliminary understanding of the nature and process of ITT in the Chinese coal mining industry. The observation data will be discussed before interview findings, since observations served as a prelude to the interviews by “guiding us to some of the important questions we want to ask respondents" (Whyte and Whyte, 1984, p.129). The aim of observation is to keep a record of ITT events in order to understand the process and channel of ITT in the Chinese coal mining industry. In addition, this researcher also visited the three coal mines in order to further understand their current development situations, opportunities and challenges as relates to ITT. The results of these observations were also used to design interview questions. The aim of the interviews is to probe the main factors which influence the effectiveness of ITT in the Chinese coal mining industry, and to develop more appropriate interview questions in order to prevent the appearance of leading questions in the interviews of main case studies. The collecting method and reliability of data will also be further assessed in the pilot case studies.

5.2 Profiles of Three Coal Mines

The following three coal mines were chosen as pilot cases to study. The researcher anonymized them as coal mine A1, coal mine B1 and coal mine C1 for ethical reasons. Observations and interviews were conducted in the coal mine A1 (a large state-owned coal mine), coal mine B1 (a local state-owned coal mine), and coal mine C1 (a small-scale township and village coal mine).

Coal mine A1 was established in 1990, and has 4,080 employees and total assets of 280 million RMB (about £28 million). It is a subsidiary company of Zhong Ping Energy and Chemical Group and is administrated by the State-owned Assets Supervision and Administration Commission of the Henan Province. Its annual coal production is 3 million tons and, with a mechanization level of 98%, it undertook 27 ITT projects in 2009. The General Manager of coal mine A1 reported that gas outbursts and explosion problems are still bothering them, as the mine has a long history and very complicated geological conditions. The coal mine has also tried to use transferred Australian technology to solve gas problems, but the effect of this ITT was not good.

Coal mine B1 was established in 1989, and has 1,020 employees and total assets of 36 million RMB (about £3.6 million). The Weidong district government of Pingdingshan city owns the coal mine B1. Its annual coal production is 600 thousand tons. The General Manager of coal mine B1 mentioned that it had achieved a mechanization level of 80%, and that its technology and management levels were ranged in the middle of the industry. Gas outbursts and explosion problems have also been bothering them. The coal mine undertook 2 ITT projects in 2009.

Coal mine C1 was established in 1996 and has 350 employees and a total asset of 22 million RMB (about £2.2 million). Coal mine C1 is privatedly owned by an invididual, and its annual coal production is 310 thousand tons. Its mechanization level has only achieved 60%, technology and management level is relatively low in the industry. Gas outburst and explosion problems have also been bothering them. It engaged in 3 ITT project in 2009.

These three coal mines have been chosen as pilot cases because they are representative of the different kinds of Chinese coal mines. They were also willing to collaborate with this study, and their positive collaborative attitude helped this researcher to obtain reliable data from pilot case studies. In the next section, the author will discuss findings taken from observations.

5.3 Findings from Observations

The Current Situation of the Three Coal Mines

This section investigates the current situation of Chinese coal mining industry in order to understand its opportunities and challenges. The planned visits to the coal mines were designed as data collection sources in order to find out useful information. This researcher also searched the websites and documents of the three coal mines in order to come to a better understanding of the development processes of the three coal mines.

When this researcher visited the coal mine A1, it appeared to be similar to the way it is described in the literature and documents. However, this good impression was subverted when the researcher visited the coal mine B1 and the coal mine C1. These two coal mines are entirely different from their descriptions in literature and documents: the coal mine B1 was still dependent on explosives to mine coal, and the coal mine C1 was still using manual mining techniques.

After visiting these three coal mines, this researcher summarized the following challenges faced by these coal mines.

- Increasing mining depth led to safe challenges, such as gas outburst and explosion.
- Increasing coal production led to excessive gas emission and environment pollution.

- Compared with developed countries, technology and equipment is relatively backward and needs to be further improved.

The researcher also summarized the following opportunities that were embedded in the development processes of the three coal mines:

- United Nations Framework Convention on Climate Change (UNFCCC, 2012) asked developed countries to transfer preferential technology to developing countries in order to help them reduce methane emissions; the UN also provided additional financial assistance to developing countries for the ITT project.
- The Chinese government also enacted relevant policies and promoted subsidies to encourage and support coal mines for improving their technology and equipment in order to promote safety levels and reduce gas emission.

The price and profit of coal is continually increasing, which means that the financial capability of coal enterprise is continually being promoted. This allows the local state-owned and the small coal mine to be given more funding to engage in ITT.

The Understanding of ITT by the Three Coal Mines

This section investigates the ways in which ITT is understood by the three coal mines. In the three coal mines, this researcher found that the concept of ITT is understood as a part of the technology trade in which the transferee purchases the transferor's technology in order to promote its production activities, such as the importing of technology and equipment. The reason for this understanding is grounded in the characteristically Chinese ideology of economic development, which focuses on using large investments to drive economic development (Gupta, 2011). This induced that most of coal enterprises' managers had misunderstood ITT, and believed that, if the transferor was willing to transfer advanced technology and if the transferee had sufficient financial capability to pay the transfer fee and invest in R&D, the advanced technology would be obtained and technological levels would be promoted after transfer. This study argued that “technology” as “systematic knowledge” (UNCTAD, 2001, p. 262) could only be learned, and was not be able to be obtained by purchase. In other words, the success of ITT relies not only on sufficient funding, but also on organisational technology management and learning.

The Necessity of ITT in the Chinese Coal Mining Industry

This section describes the significance of ITT in the Chinese coal mining industry. The researcher visited the underground tunnels of the three coal mines to observe the process of coal mining, in order to understand whether ITT is necessary, and discovered that all three coal mines had been threatened by gas problems. Even though underground ventilation systems had been in place, the researcher still smelt a very strong gas odor. The researcher spoke with an accompanying technician, asking him why gas concentration was still very high even though the ventilation system was working. The technician explained that gas was stored in coal seams and was released during the process of mining. Currently, domestic technology is unequipped to solve the problem of high gas concentrations in underground tunnels, and if the problem is not solved, the safety of production and of the lives of miners will not be guaranteed, since explosions occur when this gas takes up between 5% and 16% of the air and meets fire. The technician further said that Australian coal-bed methane (CBM) drainage technologies could effectively solve these gas problems. This technology can drain methane by drilling and extracting gas from the coal-bed before mining. Therefore, transferred CBM technology is a very effective way to solve gas problems.

The Current Situation of ITT in the Three Coal Mines

This section presents the current status of ITT in the three coal mines. The researcher found a number of positive and negative situations by observing involvement of the three coal mines in the event of ITT.

Positive situations include the following:

- The Chinese government has enacted a series of policies and regulations to create a good environment in order to encourage and facilitate ITT, such as <Implementation Regulation of National Technology Transfer Promotion Action> which was enacted by the Ministry of Science and Technology in 2007.
- Service agencies of ITT are being established with the encouragement of the government in order to provide service to coal enterprises which will engage in ITT.
- The technology management system of the large state-owned coal mine has been further improved in order to better support and manage projects involving ITT.

Negative situations include the following:

- The three coal mines lack systematic regulations to protect the IPR of the transferor during the process of ITT.
- The current educational system does not provide sufficient talented individual for coal mines, and this has resulted in a lack of professionals to work on transferred technology.
- The government has not effectively supervised the TT agency market, and although the number of agencies is increasing, their quality of service is decreasing.
- The three coal mines lack a performance evaluation system for ITT, so they did not know which aspects are wrong when the effect of ITT is not good.
- The ITT of the three coal mines lacks an auxiliary support system. An auxiliary support

system has two subsystems, a capital investment system and a technology support system. The technology support system of the large state-owned coal mine is weak, because it lacks relevant experts and technicians to form a strong support team. The local state-owned coal mine and the small coal mine lack capital investment systems and technology support systems, as the capability of their funding and technology is low and very difficult to support the digestion and absorption of transferred technology.

- Team learning in the three coal mines is very weak and needs to be further improved, since team members are not willing to share their expertise with each other.

How Foreign Technology is Transferred to the Three Coal Mines

In order to understand how foreign technology is transferred to the three coal mines, the researcher collected ITT events information by joining the mailing list of many TT agencies in order to observe ITT events of the three coal mines. The researcher also categorized ITT events which can be observed and related to selected cases as well as event time during the visit to China.

Table 5.1 below shows an example of field notes and journal entries that the researcher made when observing an ITT event.

Time: 09:00-12:00 13:00-17:00 18-20, November, 2010	**Venue:** Indoor stadium of Pingdingshan, Pingdingshan city, Henan province, China
ITT Events: International technology and equipment exhibition of coal mining industry	
Participators: 21 foreign technology suppliers and 83 Chinese suppliers managers of 93 state-owned coal mines and 36 small coal mines	
Selected case participated event:	

Coal mine A1 signed contract of ITT with America's Kennametal. Coal mine B1 signed contract of ITT with Xuzhou Huarong. Coal mine C1 signed contract of ITT with Shandong Huacheng.
Participants' comments: Manager A, the coal mine A1: "our technology level will be promoted through the ITT project; we will organise a research team to digest and absorb it as soon as possible". Manager B, the coal mine B1: "other coal mine solved gas problem through the technology; it should be also able to solve our problem". Manager C, the coal mine C1: "we want to ensure safe production, so the technology is suitable for us".
Researcher summarized: The coal mine A1, coal mine B1 and coal mine C1 each have different levels of demand to engage in ITT. The coal mine A1 hopes to solve the gas problem and promote technological level through absorption of transferred technology. Both coal mine B1 and coal mine C1 only hope to solve specific problem through ITT.

Technology transfer events summarized:

	18, November, 2010	One day event
The coal mine A1	19, November, 2010	One day event
	20, November, 2010	Half day event
	18, November, 2010	One day event
The coal mine B1	19, November, 2010	One day event
	20, November, 2010	Half day event
	18, November, 2010	One day event
The coal mine C1	19, November, 2010	One day event
	20, November, 2010	Half day event

Table 5.1 A sample of field notes of direct observation.

The researcher had an informal conversation with relevant participants at the end of each ITT event. Each participant made comments about each ITT event. The researcher anonymized them instead of alphabet D, E and F for ethical reasons. Moreover, the researcher went back quickly to a quiet room after each ITT event in order to write field journal entries while still fresh in the memory.

After observation and exploration of the processes and channels of ITT in the three coal mines, the researcher found that the ITT processes of the three coal mines had a number of similarities. First of all, the three coal mines, as transferees, identified their own technology requirements and began to look for and select appropriate technology in the international market. After this, transferees negotiated with transferors after finding the appropriate technology on the market, and the two parties signed the ITT contract if both the technology and the transfer fee were suitable. Transferors agreed to continue to provide technical assistance afterwards in order to help transferees to further digest and absorb transferred technology.

Besides these similarities, the ITT channels of these three coal mines focused mainly on licensing and importing equipment rather than on foreign direct investment and joint ventures. The reasons for this will be investigated through interviewing key informants in the three coal mines.

Factors Influencing the Effectiveness of ITT

This section explores factors that influenced the effectiveness of ITT in the three coal mines.

The following factors have been identified through observation:

- The three coal mines lacked a good technology management team to supervise the ITT process, and top managers did not pay attention to technology management.
- The coal mine B1 and the coal mine C1 lacked sufficient funding to engage in ITT.
- The government has not paid enough attention to the protection of IPR, which leads to transferors worrying that their IPR may be copied by other competitors.
- The three coal mines lacked relevant talented individuals to learn and absorb the transferred technology.

5.4 Findings from Semi-structured Interviews

After a preliminary analysis of the observation data, questions are designed in a semi-structured interview format in order to provide an in-depth understanding of factors influencing the effectiveness of ITT. Table 5.2 (below) presents information about the interviewees in the pilot study.

Job Title	Type of Coal Mine
General Manager	Coal mine A1
General Manager	Coal mine B1
General Manager	Coal mine C1
General Engineer	Coal mine A1
General Engineer	Coal mine B1
General Engineer	Coal mine C1
Director of Technical Department	Coal mine A1
Director of Technical Department	Coal mine B1

Director of Technical Department	Coal mine C1

Table 5.2 Interviewees of semi-structured interview

The interviewees in the pilot case studies were the general managers, general engineers and technical department directors of the three coal mines, as these positions tend to be more authoritative in providing the overall status of the three coal mines. The interview was conducted in a less formal manner in order to make the interviewees feel comfortable and thus to obtain reliable feedbacks. The findings of the interview are presented in the following paragraphs.

The Current Situation of the Three Coal Mines

Currently, 70% of coal mine A1 technologies are from domestic suppliers, and 30% of technologies are from foreign suppliers. 10% of coal mine B1 technologies are from foreign suppliers, and 5% of coal mine C1 technologies are from foreign suppliers. Coal mining of mine A1 and mine B1 has already achieved mechanisation, but the coal mine C1 still depend on manual mining. The three coal mines has obtained some technological progress after learning and absorbing foreign technology, but the core technologies are still imported.

The Understanding of ITT by the Three Coal Mines

The technical department director of the coal mine A1 thought that ITT was generally a process of learning foreign know-how. The technical department directors of the coal mine B1 and the coal mine C1 thought that ITT was the same as purchasing or importing foreign technology. The general engineer of the coal mine A1 also thought that concepts of ITT were gradually changing from the importing of technology to learning knowledge.

The general managers of the coal mine B1 and the coal mine C1 believed that ITT was essentially a kind of technology trade in which the buyer purchased advanced technology from the seller, and as long as the coal mine had enough funding, it would gain advanced technology. The general engineer of the coal mine A1 thought that ITT was not only a transfer of hardware, such as equipment or machinery, but also a transfer of software, such as management experience and know-how. The director of the technical department of the coal mine A1 pointed out that ITT was a transfer of system knowledge and that advanced technology was not able to be gained by purchasing, but by learning.

The Necessity of ITT in the Chinese Coal Mining Industry

The general manager of the coal mine A1 mentioned that gas accidents occurred almost every day in the Chinese coal mine industry. The total death toll within the Chinese coal mining industry was 2433 people in 2010 (State Administration of Work Safety, 2011), showing that the Chinese coal mining industry killed more than 6 miners every day; these numbers accounted for about 70% of the world's coal mining casualties in 2010.

The general engineer of the coal mine A1 stated that deaths by gas explosion were the most numerous at 593 in 2010, which accounted for 24% of total deaths in the Chinese coal mining industry. In addition, more than 70% of coal mines A1 have high gas content and gas outburst.

The technical department director of the coal mine A1 explained in more detail that methane (also known as CH_4 and the primary constituent in natural gas) was stored in coal seams and would be released in the process of coal mining. When CH_4 takes up between 5% and 16% of the air, and meets fire, an explosion will occur. The general engineer of the coal mine A1 further pointed out that the Chinese coal mining industry released about 10 billion cubic meters of methane every year through the process of coal mining with ventilation systems, which accounted for about 40% of global methane pollution in 2010. The levels of released gas will continue elevating as production increases.

Moreover, according to Hexun (2011), China’s methane emissions will jump to 45% of global methane emissions by 2020 if China does not take measures to control it. Moreover, methane causes 20 times more damage in greenhouse effects than carbon dioxide when it is released in the air, also its ability to damage the ozonosphere is 10 times higher than carbon dioxide. Most Chinese coal enterprises release methane directly into the air. In recent years, many countries have begun to develop low-carbon economies, which will become the new model of global economy development in the future. Therefore, solutions to control and utilize methane in order to solve the problems of gas explosions and environment pollution have already become the most pressing questions in the Chinese coal mining industry.

The former Chinese Premier Wen Jiabao, who used to be a mining engineer, pointed out (2005) that ‘the lack of relevant technology and equipments to control and utilize the methane inducing frequent appearance of coal mine accident’. The latest technology on coal-bed methane (CBM) drainage can effectively solve gas problems, it can drain methane by drilling and extracting the gas from the coal-bed before mining, thus reducing the methane content in coal-bed (Figures 5.1, 5.2, and 5.3). This can improve coal mine safety and reduce methane emissions.

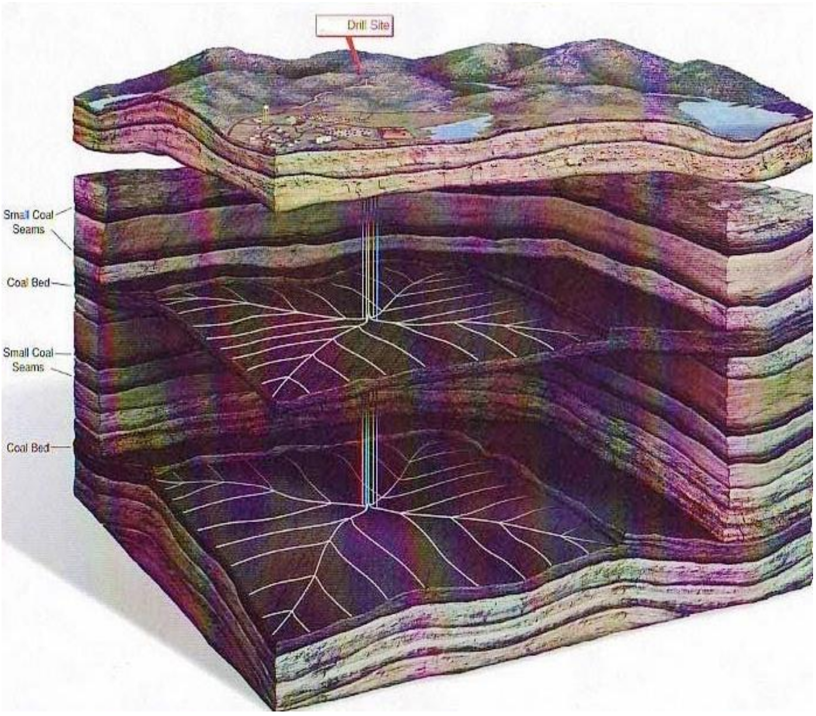


Figure 5.1 Site of Borehole for Extracting Methane (Liu, 2008)

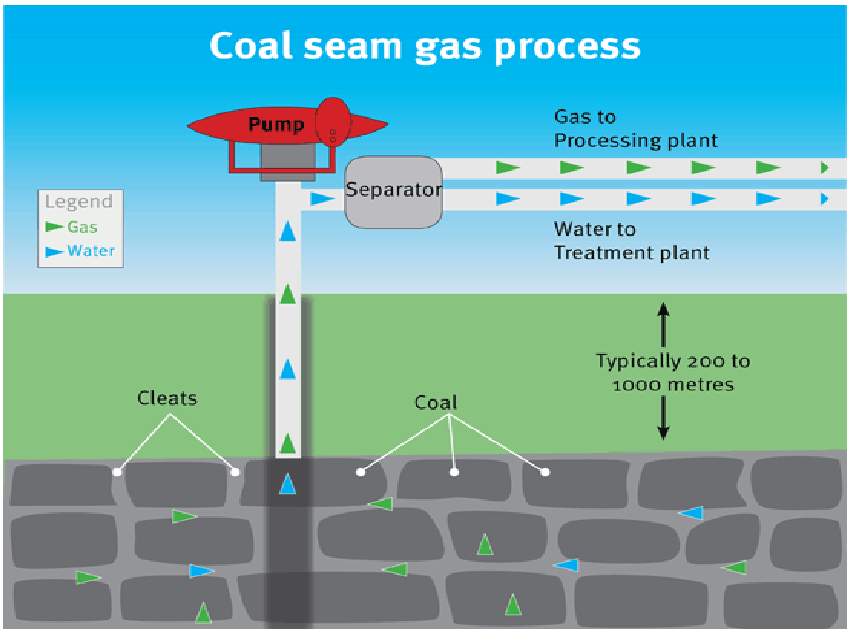


Figure 5.2 Utilizing Pump for Extracting Methane (Liu, 2008)

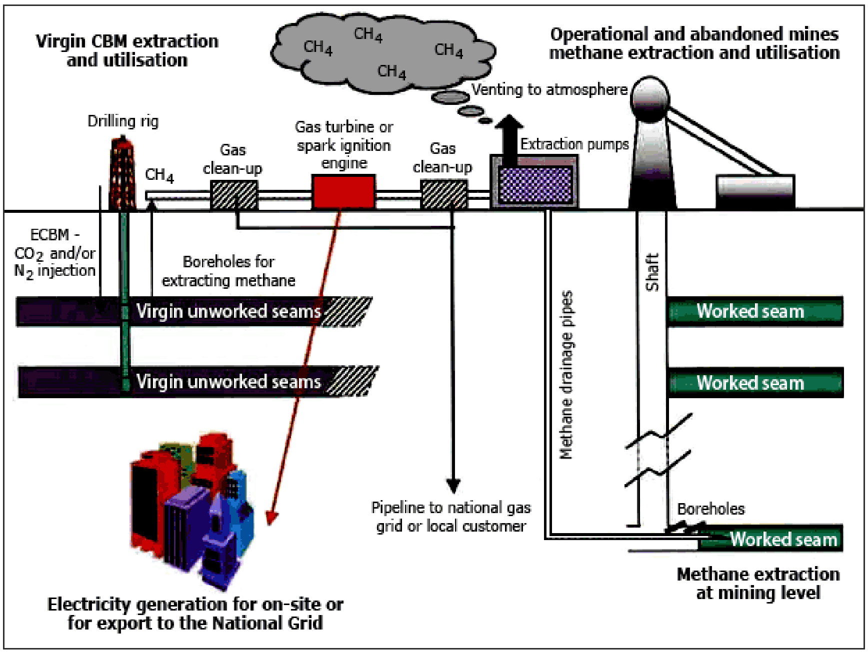


Figure 5.3 Process of Coal-bed Methane (CBM) Extraction and Utilization (Liu, 2008)

The general engineer of the coal mine A1 spoke about the current developments in CBM drainage technology; he believed that the following two factors affect development of the technology.

- Permeability of coal seam
- Parameters of drilling drainage

Improving coal seam permeability is a worldwide problem, and it has failed to achieve significant results through years of research.

The parameters of drilling drainage have many aspects, such as density of drilling, distribution of drilling, depth of drilling, diameter of drilling, negative pressure of drainage, etc. The technology of drilling rig has already undergone significant development in American and Australian enterprises through years of research, but China has fallen behind in this field and has had to transfer other technologies in order to solve gas problems.

The Current Situation of ITT in the Three Coal Mines

The general manager of the coal mine A1 introduced that they had tried to import a technology for drilling 1000m from the Australia Valley Company through licensing in 2003. The Chinese coal mine also hoped to drill down 1000 meters using the technology, but was only able to drill down 300 meters. After the results of the ITT were unsuccessful, the coal mine began to worry about importing foreign technology.

By studying the reasons for unsuccessful ITT, it was found that the actual drilling capacity of the machine not only relies on the operational skill of technicians, but also depends on the geological condition of the coal seam, particularly its hardness. This means that different geological conditions and sub-par operational skills will lead to unsuccessful ITT.

Generally, the transferred technology has been researched and developed according to the local situation and environment of the transferor, and thus may not work effectively if the technology is applied to a different location and environment. This is a common-sense issue in ITT, but it was not considered by the coal mine before importing the technology. Therefore, this researcher argues that the coal mine lacked professionals and relevant talented individuals.

It was also found that individual learning, team learning, organisational learning and inter-organisational learning have all been adopted for ITT at the coal mine A1. However, the effect of team learning is weak, and the aforementioned inappropriate operation of the transferred technology was a consequence of teamwork. In addition, the coal mine B1 and the coal mine C1 both face challenges of funding and technology capability. Owing to their small size and low production, funding for ITT is insufficient. Moreover, their technology levels are relatively low, even if they have sufficient funding, and the insufficient technology capability leads to difficulties in digesting and absorbing transferred technology because of the existing gap in technology between them and the transferor.

Therefore, further investigations will be carried out in the main case studies in order to understand the reasons behind the above issues.

How Foreign Technology is Transferred to the Three Coal Mines

The general managers of the coal mine A1 and coal mine B1 stated that the government formulated a series of policies to ensure state-owned coal enterprises gained substantial coal resources, as coal is a national strategic resource. These policies essentially limited foreign direct investment from controlling important coal sources when foreign enterprise invested in the Chinese coal mining industry. In addition, the joint venture could only be set up when the Chinese company involved is the majority shareholder. Therefore, the coal mine A1 and coal mines B1 must use licensing, rather than FDI or joint ventures, to engage in ITT. Moreover, the coal mine C1 mainly focuses their ITT channels on purchase and import technologies.

Factors Influencing the Effectiveness of ITT

ITT is a very complex process and involves a number of dimensions, and each dimension includes many factors. The general manager of the coal mine A1 stated that the government is a vital dimension influencing the effectiveness of ITT. The general engineer of the coal mine A1 also pointed out that relying solely on international treaties and laws are not enough, the coal mine A1 still needs the government to make relevant policies and regulations in order to coordinate and facilitate ITT activities.

The general engineers of the three coal mines stated that a lack of professional ITT individuals affects licensing, and coal mines hope to employ talented individual with in-depth experience who are good at licensing. The technical department director of the coal mine A1 said that the degree of protection given to intellectual property rights is also a very important factor affecting licensing. The general managers of the coal mine B1 and the coal mine C1 believed that sufficient funding is an important factor influencing licensing.

5.5 Chapter Summary

Pilot study was very useful and even ’invaluable’ in this study, it give this study a trial run, otherwise there is no way to ensure this study is running successfully. The pilot study helps the researcher to gain a preliminary understanding of the current situation of the three coal mines and the ways in which the concept of ITT is understood by the three coal mines. It has also explored the necessity of ITT and the current status of ITT in the three coal mines, the channels of ITT, and the factors influencing the effectiveness of ITT. The discussion of these issues has helped the researcher to identify reliable data resources and to improve their data collection strategies in order to gain more accurate data in the main study. It also helped to refine the interview questions and avoid the appearance of leading questions. The pilot study has also promoted the interviewing techniques of the researcher and identified more key informants. Lastly, it has helped the researcher to structure a pre-analysis of data in order to test and improve current data analysis methods for acquiring more reliable analytical results.

The findings and key implications from the pilot case studies are summarized as follows. First, the current developmental status of the Chinese coal mining industry does not match the description given in previous studies. In other words, a gap exists between the descriptions in literature and the real situation of the Chinese coal mining industry. The development of the Chinese coal mining industry is unbalanced, both the best and worst coal mines are located in China, and the historical blindness in policy is the main cause of this.

Second, there are misunderstandings surrounding the concept of ITT in the Chinese coal mining industry. Most of the interviewees believed that ITT is essentially a kind of technology trade, and acquisition of advanced technology relies on sufficient funding rather than on technology management and learning.

Third, ITT is necessary to the Chinese coal mining industry because it is an effective way to solve the problem of gas. However, the current status of ITT in Chinese coal mining industry is not satisfactory.

Fourth, ITT channels in China mainly focus on licensing rather than foreign direct investments or joint ventures. The main reason is that coal, as a kind of nationally strategic resource, has been protected and controlled by the Chinese government. FDIs have not been encouraged to enter the Chinese coal mining industry, and joint ventures can only be set up when the Chinese company is the majority shareholder.

Fifth, the interviewees understood the government, the protection of intellectual property rights, sufficient funding and professional ITT individuals to be the main factors influencing the effectiveness of ITT.

In addition, owing to the fact that this researcher has met with good academic cooperation from Chinese senior government officials in the past, they gave strong support to this project. Therefore, this researcher was able to gain reliable information during observations and interviews. In most cases, researchers from universities outside China are not permitted to go into Chinese coal mines unless the purpose of research are strictly for pure academic use, and permission must be obtained from top politicians before conducting the research.

Furthermore, each coal mine is different, such as management system and organisational structure. Because of this, it is unclear whether the findings of the pilot case studies can be applied to the main case studies. The Chinese coal mining industry is different from that in other countries, and the production from state-owned coal mine accounts for 80% of the entire industry's production. A strong centralized political and planning system dominates the management of state-owned coal mines, and they need to follow the pace of the central government to manage these coal mines. Most state-owned coal mines employ similar management behaviors in dealing with the same business.

Moreover, the State Council has launched <stat-owned enterprise information disclosure implementation measures> on 5 February 2009, which released information about state-owned enterprises to the public. This release of information showed that Chinese state-owned coal mines had the same or similar organisational structures and management systems, which was confirmed by the findings from the pilot case studies. This means that all state-owned coal mines have nearly identical functional departments, which play the same or similar roles. The current research investigates ITT from a managerial perspective rather than from a technological perspective, and it is therefore argued that the findings of the pilot case studies can be applied to the main cases studies.

Chapter Six – Presentation of Main Case Studies

6.1 Introduction

Previously, chapter two and three reviewed the extant literature concerning ITT and the Chinese coal mining industry; chapter four presented the details of research design; and chapter five helped to identify more reliable data resources and improve strategies of data collection and analysis. The systematic conjunction of these chapters helps the researcher to build confidence and also paves the way for conducting the following main study. This chapter presents the findings of those main case studies. An analysis of each case is organized under the following five themes: the current situation of coal mines, the understanding of ITT by managers, the necessity for and current situation of ITT, the ways in which technology is transferred and the factors that influence the effectiveness of ITT.

Three representative coal mines were chosen as the focus of the main case studies: a large state-owned coal mine, a local state-owned coal mine and a small coal mine. The researcher anonymized them as coal mine A3, coal mine B2 and coal mine C5 for ethical reasons. The selection criteria and justification of this choice were presented in 4.5.1. The analysis sequence of the main case studies follows the interview sequence from the large state-owned coal mine to the local state-owned coal mine and then to the small coals mine.

6.2 Large State-Owned Coal Mine

"Engagement in ITT by the large state-owned coal mine is to promote its own technology level in order to catch up with developed countries" (general manager of the coal mine A3, 6th July 2011). Compared with the large coal mines of the US and Australia, the technology levels of large state-owned coal mines in China are still low, and most advanced technologies still rely on foreign enterprises. This general manager commented that the long-term planned economy meant that the Chinese coal mining industry was over-reliant on resources, and this makes coal mining a labor-intensive industry.

'… our mine has 3,820 staff, and one with the same production scale in the USA or the Australia only has less than 100 staff … the main reason for this big difference is backward technology' (general engineer of the coal mine A3, 6th July 2011).

The large state-owned coal mine also hopes to elevate its technology levels through ITT, but this requires a longer process of knowledge accumulation. Looking at the experiences of developed countries, we can see that only the UK relied on its own technological innovation to achieve industrialization; other developed countries achieved industrialization through digestion and absorption of transferred technology, such as the US learns from the UK, Japan learns from the US and Korea learns from western European countries (Liu, 2006). They also pay more attention to promoting innovation capability in the process of learning.

ITT may bring a competitive advantage, but this advantage is only temporary. If a country or industry hopes to obtain a sustainable competitive advantage, they must innovate based on transferred technology. The large state-owned coal mine is already aware of this. The general engineer commented that "we hope to gain advanced foreign technology, but if the coal mine relies on ITT rather than innovation, we will fall into a vicious circle that it is "transfer--backward--transfer again--backward again… we need to innovate based on transferred technology in order to gain sustainable competitive advantage" (general engineer of the coal mine A3, 6th July 2011).

Currently, the large state-owned coal mine not only relies on transferred technology to solve the problems it faces, but also tries to digest and absorb transferred technology in order to research and develop better technology.

The Current Situation of the Large State-owned Coal Mine

The coal mine A3 was established in 1954 and is one of the earliest coal mines of New China (New China was founded on 1st October 1949). Currently, 70% of its technologies are purchased from domestic suppliers and 30% from foreign suppliers such as Germany and Australia (general engineer of the large state-owned coal mine, 6th July 2011). The coal mine A3 has 3,820 employees and a total asset of 260 million RMB (about £26 million). Its market goal is to keep its current scale and continue to increase production, thus achieving 3 million tons per year; its current production is 2.8 million tons per year, which ranked it in the middle position of nationwide large state-owned coal mines (general manager of the coal mine A3, 6th July 2011).

In today's open and competitive environment, science and technology are primary productive forces. Scientific and technological progress changes the development model of coal mine from a high-input, high-consumption and low-output system to a low-carbon and environmentally friendly one. The coal mine will not rely on price competition by reducing costs and expanding production to occupy market shares, but by promoting technological progress through ITT and innovation.

'The main challenge that the coal mine facing is safety problem, which primarily concentrates on gas accidents '(general engineer of the large state-owned coal mine, 6th July 2011). 'Our technology needs to be improved in order to solve the gas problem, which is the most troubling problem of our mine', said the director of technical department of the coal mine A3, 6th July 2011.

Owing to reasons of cost and technology, the coal mine must discharge a large amount of methane into the air after draining the methane from the coal seam. The greenhouse effect of methane is twenty times that of carbon dioxide, so it is increasingly urgent for China to reduce its emission of polluting gases using industrial transformations and upgrades. A low-carbon economy forces the large state-owned coal mine to adjust their development model. Therefore, they urgently need new CBM drainage technology which can reduce gas accidents and store methane for further use.

Interviewees at the coal mine A3 also commented that enterprise management has not been a main problem for them for some time, but that technology management is still a problem. (general manager of the coal mine A3, 6th July 2011).

The Understanding of ITT at the Large State-owned Coal Mine

The ideology of Chinese economic development had a direct affect on the development of the large state-owned coal mine. Through observations and interviews, it was found that this ideology required the large state-owned coal mine to pay more attention to development speeds rather than quality, which caused a number of accidents and environmental pollution. Owing to the improvement in living standards, the miners are pursuing safer working environments. The large state-owned coal mine has changed its development model in recent years, and it has begun to pay more attention to promoting its technology level rather than merely increasing production, in order to guarantee safety and to reduce environmental pollution. This change taught managers of the large state-owned coal mine that ITT is not purely spending money to buy technology, but rather learning and absorption of transferred technology.

One interviewee made the following comment:

‘We used to think that as long as we have enough funding, we can gain advanced technologies from foreign companies through purchase. But we are realizing that money may not buy technology, we should focus on how to learn and absorb technology’ (general manager of the coal mine A3, 6th July 2011).

In addition, two interviewees explained their understanding of ITT: ‘ITT is a kind of technology trades that the transferee buys technology for their production activity from transferor such as an import of technology and equipment’ (director of mining department of the coal mine A3, 6th July 2011).

‘ITT is the way that the transferees use to acquire technology from the transferors. It transfers not only hardware such as equipment or machinery, but also transfers software such as management experience and know-how’ (director of technical department of the coal mine A3, 6th July 2011).

Based on the above interviewees’ responses, the researcher discovered that most interviewees were changing their concept of ITT from the buying of technology to the learning of knowledge. This study argues that ITT is undoubtedly the way of technology development and innovation.

The Necessity of ITT in the Large State-owned Coal Mine

Production in Chinese large state-owned coal mines reached 2.8 billion tons in 2010, which accounted for 87% of the national coal output. Six interviewees from the coal mine A3 pointed out that the coal mine A3 faced the challenge of safety problems.

One interviewee further commented that 'the coal mining industry itself is with high risk. Special production environment, variability of work environment and agnostic of geography structure result in that the industry has a higher probability of accidents' (general engineer of the coal mine A3, 6th July 2011). Safety is the eternal watchword in the coal mining industry, and safe production is a fundamental requirement, since it guarantees efficiency. At the same time, it is also a precondition which guarantees the social stability of mining districts. The State Council formulated <State Council about Prevention Coal Mine Accident Special Provisions> on 3rd September 2005, and Article XI of the provisions required that the coal mining business must be stopped for sixty days once after a large-scale accident occurs. In addition, according to the regulation of the State Administration of Coal Mine Safety, it must be stopped at least for half a year and key managers will be dismissed immediately if a serious accident occurs. The serious accident is defined as one in which the death toll is more than three and less than nine. Once a coal mine stops its business, its staff will not be able to be paid on time. Furthermore, the dismissed managers will not be able to be employed as a manager at any other coal mine (general manager of the coal mine A3, 6th July 2011). Therefore, guaranteeing safe production is the most important issue at the large state-owned coal mine.

The general engineer of the coal mine A3 considered that strengthening safe management and transferring advanced technology may be an effective way to solve the safety problem. In order to solve this problem, the causes of accidents need to be understood. Six interviewees at the coal mine A3 commented that safety problems are mainly focused on gas explosion. Once a coal mine has gas explosion, death toll must exceed three. In 2010, there were 110 serious accidents in China's coal mining industry; 59 of the 110 accidents were gas explosions, which accounted for 54% of total serious accidents.

'Open flame and gas accumulation are two essential reasons of gas explosion'(general engineer of the coal mine A3, 6th July 2011). Why are the open flames unable to be exterminated underground through scientific management? The general engineer of the coal mine A3 further explained that since the coal mine A3 has a longer mining history, the miners need to mine deeper coal seams which have more complicated geographical structures and higher temperatures. Higher temperatures underground always results in friction heating of machinery, and the equipment do not radiate the heat rapidly enough, which is likely to cause the conveyor belt and lubricating oil to catch fire. In addition, the inappropriate operation of electrical drilling machines and the aging of cables and wires can also cause open flame. Sometimes, high temperatures underground also caused spontaneous combustion of coal, even though miners are not permitted to carry lighters or electronic products underground. Owing to the large numbers of uncontrolled factors underground, it is simple to induce open flame, and considering the current technology level of the coal mine A3, it is difficult to eliminate open flame underground.

This raises another issue, if the open flame underground is not eliminated, will the coal mine A3 be able to reduce gas accumulations in underground tunnels? Before answering this question, the researcher needs to discuss how gas is formed. The general engineer of the coal mine A3 explained the cause of gas generation. Ancient plants underground experienced a long period of biochemical action under high temperatures and pressures, then ultimately formed coal, a kind of complex porous solid, including a large number of pores and cracks. In the process of coal formation, cellulose and organic matter from ancient plants decompose through the efforts of underground anaerobic bacteria, and gas is produced in the process of decomposing.

In addition, coal has great absorption capacity; the enormous pressure of the deep coal seams makes its absorption capacity stronger, gas has temporarily been stored in pores and cracks under enormous pressure. Gas is both highly permeable and quickly diffuses at a speed 1.6 times greater than air. It is very easy for gas to penetrate and diffuse into underground tunnels and excavation spaces through rock cracks and structurally loose coal seams. This means that the gas concentration in deeper coal seams is higher than shallow coal seams; the enormous pressure of the deep coal seam reduces the permeability of gas and allows a tremendous amount of gas to be stored in deeper coal seams, and diffused gas has to pass longer distance to ground. The director of the technology department further stated that since the vertical depth of the large state-owned mine exceeds 1,500 meters, massive amounts of gas would be released into the tunnel when deeper coal seams are mined, and due to the complicated geographical structure of the deeper coal seam, the ventilation system is only able to drain a fraction of the gas. This is the reason this researcher sensed a strong smell of gas when visiting the underground tunnel of the coal mine A3.

Comparing eliminating open flame with reducing gas accumulation, the former involves a wide range of uncontrolled factors, whereas the latter may be relatively simple. The reasons for gas accumulation can be understood mainly by investigating the two following aspects: whether or not the ventilation systems of coal mines have been managed scientifically, and whether or not coal mines can effectively drain methane from coal seams before mining.

Interviewees reported that the ventilation system of the coal mine A3 was scientifically managed, but it is difficult for current domestic CBM drainage technology to drain methane effectively from deeper coal seams before mining. It was found that domestic technology can drain gas from shallow coal seams whose drilling depth only reaches 700m underground. Australian CBM drainage technology can drill to 1,500m underground and drain gas effectively from deeper coal seams before mining.

In addition, interviewees gave another reason for adopting Australian rather than Chinese CBM drainage technology. Owing to the State Council formulated <the opinions about accelerating drainage and utilization of coal seam methane> on 15th June 2006, and according to the fifth Article of the regulation, coal seams can only be mined when the gas concentration of the coal seam is drained below a standard requirement. The coal seam cannot be mined if gas concentration is above the standard requirement. The Article has forced large state-owned coal mines to drain methane before mining. Moreover, according to Article VII of <the opinions about accelerating drainage and utilization of coal seam methane>, all coal mines were prohibited from emitting methane directly into the atmosphere by ventilation and drainage systems, and the State Environment Protection Administration will supervise all coal mines and punish illegal emission behavior. The general manager of the coal mine A3 pointed out that the gas drained by China's coal mining industry doubled from 2005 to 2010.

Moreover, the general engineer of the coal mine A3 further considered that there were two main factors affecting CBM drainage: the permeability of coal seams and the parameters of drilling drainage. The permeability improvement of coal seams is a worldwide problem, which has failed to be solved even after years of research. Parameters of drilling drainage includes many aspects, such as density of drilling, distribution of drilling, depth of drilling, diameter of drilling, negative pressure of drainage, and etc. The technologies of drilling rigs have already undergone significant development by foreign enterprises through years of research. Currently, the drilling technology in the US and Australia is very advanced, but China still lags behind. Therefore, 'the coal mine A3 has to acquire foreign CBM drainage technology to solve the gas problem'(general engineer of the coal mine A3, 6th July 2011).

The Current Situation of ITT in the Large State-owned Coal Mine

Since the average coal price has increased from 246 RMB/Tonne (Xinhua, 2005) to 618 RMB/Tonne (Sina, 2013), the large state-owned coal mines do not need to worry about funding when engaging in ITT, as they have abundant capital to acquire advanced foreign technology. One interviewee made the following comment:

'Economic efficiency of our mine is improving in these years and we spent money to import Australian technologies and equipments in order to promote our technology level ... To be honest, the performance and quality of foreign technologies are better than that of the Chinese, but 70 percent of our technologies are still from domestic suppliers based on lower cost, only 30 percent of technologies are from foreign suppliers' (general engineer of the coal mine A3, 6th July 2011).

The interview data further revealed that main reason for the coal mine A3 adopting foreign technology was because of national mandatory policies which require them to solve gas problems before mining in order to guarantee safe production. Additionally, foreign technologies and equipment are more reliable and can be more efficient in solving gas problems; although their prices are more expensive than domestic ones, the coal mine has to adopt them based on considerations of safety and efficiency.

Therefore, the coal mine A3 transferred Australian CBM drainage technology, and the methane content in deeper coal seams was reduced remarkably after adopting the technology. However, interviewees at the coal mine A3 reported that the results were not as satisfactory as expected. One interviewee made the following comment:

'We transferred Australian technology to solve gas problem in 2003, but the effect is not good … sometimes, an inappropriate operation leads to the transferred technology out of service…we have no idea how to fix it when the transferred technology is out of order…we try to learn know-how about the transferred technology, but learning effect is not good…' (General Engineer of the Coal Mine A3, 6th July 2011)

How Foreign Technology is Transferred to the Large State-owned Coal Mine

Through observation and interviews, the researcher summarized seven steps for coal mine A3 to gain technology from foreign companies.

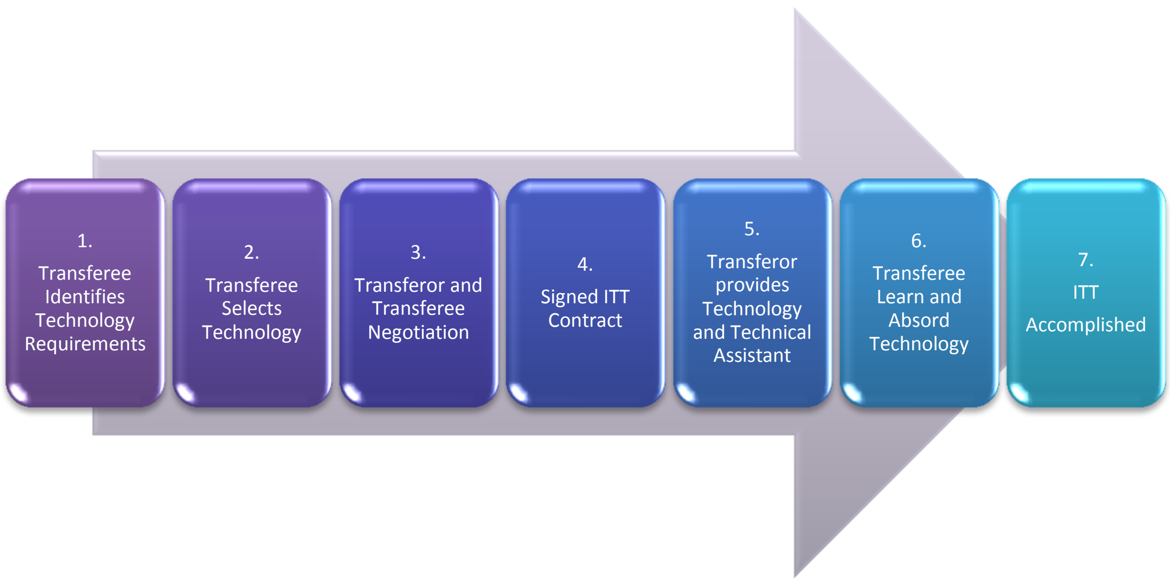


Figure 6.1 steps of ITT of the coal mine A3

From existing literature, it is clear that foreign direct investments and joint ventures are the two most common channels adopted by ITT. However, it was found that foreign technology has always been transferred to large state-owned coal mines through licensing rather than through foreign direct investments and joint ventures. Since coal in China is a national strategic resource taking up a pivotal position, and 72 percent of China’s energy consumption is from coal (Cha, 2012), the Chinese government formulated a series of policies to protect large state-owned coal mines and to allow them to gain substantial coal resources, and these policies essentially limited foreign enterprises from investing and controlling coal sources in China. On the other hand, the Chinese government does not encourage FDI in the Chinese coal mining industry, even if foreign enterprises wish to set up joint ventures with Chinese coal enterprises. The joint venture can only be set up under a condition that the Chinese investors hold majority share. These factors explain why the large state-owned coal mine has to adopt licensing rather than foreign direct investments or joint ventures to obtain foreign technology.

Factors Influencing the Effectiveness of ITT

Through observation, interviews, and analysis of the seven main steps undergone by the coal mine A3 while engaging in ITT, two main stages were found in this process: acquisition and absorption of technology. Technology acquisition is an external integration process whereas technology absorption is an internal learning process. The acquisition and absorption of technology are of the same importance to the coal mine A3, and they both influence the effectiveness of ITT. It was also revealed that improving effectiveness of ITT requires the coal mine A3 to pay more attention to both stages. Figure 6.1 indicates the ITT process: from the first to the fifth steps represent technology acquisition, whereas the sixth and the seventh steps represent the process of absorption.

Government and Technology Management Influencing the Effectiveness of ITT

Table 6.1 and Table 6.2 present interviewees' comments concerning factors that affect the acquisition and absorption of technology. These factors are divided between government and organisational technology management.

Government
'… The government is a vital factor affecting ITT, because all policies have been made by the government, these policies directly affected the efficiency of ITT ……The government should draw up appropriate policies to facilitate coal mines to engage in licensing…Developing professional TT agencies is an effective way to improve licensing effect, and also the government should encourage development of agency for ITT…' (general manager of the coal mine A3, 6th July 2011).
…To improve effect of licensing, the government should draw up a strategy of technology innovation in order to encourage coal mines to digest and absorb transferred technology for further innovation, the innovation strategy should be based on practical situation of coal mines rather than governmental purposes…' (director of technical department of the coal mine A3, 6th July 2011)

'…Government should make relevant policies to encourage coal mines to innovate, invest in R&D and cooperate with universities and state research institutes, which will help coal mines to improve licensing effect…a number of provincial governments have not investigated real context of coal mines before making relevant policies, also the government has not heard advices and feedbacks from coal mines. So the consequence is that new policies have been made easily but implemented difficultly. In addition, a number of policies intervened coal mines to follow their own requirements to learn know-how for innovation…Licensing effect will be improved if the government is able to provide relevant financial support...' (deputy general manager of the coal mine A3, 6th July 2011)
'…We are lack of professional individuals to absorb and digest transferred technologies...the reason for talented individual -shortage is the government made a series of policies blindly for increasing coal production in the past…The government should improve current education system in order to provide sufficient talented individuals…' (general engineer of the coal mine A3, 6th July 2011)

Table 6.1 Interviewees' comments concerning the government

Organisational Technology Management
'…we invited external agencies to help coal mines to select technologies before ITT in order to achieve good licensing effect…' (deputy general manager of the coal mine A3, 6th July 2011)

'…relevant training is very important before licensing, and it is able to help staff to understand transferred technology and learn relevant knowledge in order to further digest and absorb transferred knowledge for improving licensing effect.…'(director of mining department of the coal mine A3, 6th July 2011).
'…Achieving good licensing effect need enterprises to create a good learning environment in order to let staff to continually and effectively digest and absorb transferred knowledge…Organisation should arrange professional staff to select technologies before ITT in order to guarantee that transferred technology is appropriate …the IPR protection is vitally important to improve licensing effect…' (general engineer of the coal mine A3, 6th July 2011).
'…Technology management is very important, but most managers are good at enterprise management rather than technology management. China's coal mines lack talented individuals who are good at technology management……'(general manager of the coal mine A3, 6th July 2011)
'…Sufficient funding is able to help enterprises to buy technologies, but funding is not able to assist coal mines to achieve good licensing effect… technology level of China's coal mining industry should have been the highest in the world if money is able to buy knowledge…' (director of technical department of the coal mine A3, 6th July 2011)

Table 6.2 Interviewees' comments concerning organisational technology management

In addition, data drawn from observations and semi-structured interviews showed that effect of licensing on the coal mine A3 is better than on the coal mine B2 and the coal mine C5. This means the output of the coal mine is an important factor affecting the effectiveness of ITT. The following is an interviewee's comment:

‘…Generally speaking, licensing effect of a large coal mine is better than a small coal mine, because a large coal mine has higher coal output, it means good economic performance, which also means the large coal mine has sufficient funding to develop R&D and promote technology level…’ (director of technical department of the coal mine A3, 6th July 2011).

Four Levels of Learning Influencing the Effectiveness of ITT

Most interviewees also pointed out that the absorption of transferred technology is the main challenge faced by the coal mine A3. “Technology” is a type of “systematic knowledge” (UNCTAD, 2001, p. 262), and process of absorbing technology is the learning process of systematic knowledge. The coal mine A3 needs to merge absorbed knowledge into its organisational operations in order to promote its competitive advantage. In other words, knowledge obtained from the transferor should be merged into the existing knowledge system of the transferee in order to develop further knowledge to support a sustainable competitive advantage. The process of knowledge transfer is also the process of the transferee’s knowledge accumulation through learning. The complexity of transferred technology requires the transferee to provide the same level of learning, which means that the more complex the technology, the higher capability of learning required. Therefore, improving learning capability is an effective method for improving the effectiveness of ITT, if there is a gap between the required and the existing learning capabilities. It is also known that an organisation consists of multiple levels of learning, such as the individual, team, organisational, and inter-organisational levels (Beeby and Booth, 2000; Crossan et al., 1999; Nonaka and Takeuchi, 1995; Robinson et al., 1997). Many researchers state that new learning begins with individuals, including Argyris & Schon, 1996; Kim, 1993; and Simon, 1991. Although the unit of learning is the individual, it also occurs in the organisation as a collective action and is considered to be a social process. Hall (2001, p. 19) put it succinctly by claiming: ‘‘Knowledge creates knowledge only when it is shared’’. Crossan et al (1999) further argued that new knowledge had to be transferred and instituted into the wider organisation through organisational learning. With a rapid change in the external environment, it becomes difficult, if not impossible, for an organisation to develop all the required competencies (Hatten & Rosenthal, 2001). Inter-organisational learning helps organisations to sustain a competitive advantage in fierce environments.

Table 6.3 presents comments from interviewees concerning factors that affect the absorption of transferred technology. These factors are separated into the following four categories: individual, team, organisational, and inter-organisational learning.

Individual Learning
‘…Most of staffs are not willing to share know-how in learning process…There is very huge competition pressure among staffs, so each staff is worrying others learning more know-how than themselves in sharing process. One is able to present more performance in working if you acquired more know-how, and it will make you obtaining more opportunity for promotion…although staffs have to share learning experience and progress with other members in the process of learning, the sharing is only common knowledge rather than know-how…’ (director of technical department of the coal mine A3, 6th July 2011)
Team Learning
‘…the team learning is an important factor to affect licensing effect…’ (general engineer of the coal mine A3, 6th July 2011)

'…the team learning focus on finishing learning tasks that they are distributed by top leaders, goal of individual learning is to finish a part of learning task. Owing to learning task has been distributed passively by top leaders rather than initiatively selected by each team with their interests and advantages…Sometimes, easy tasks might be distributed to teams whose captains have a good relationship with top leaders, while difficult tasks might be distributed to teams whose captains have a weak relationship with top leaders... Moreover, coal mines lack incentive mechanisms to encourage individuals to finish learning tasks. Generally, individuals are not interested in the learning task, but they have to finish the task and keep common goals with the team. Because individual bonus will be deducted if the learning task has not been finished on time… the manager should not too participate or interfere in learning activities, less interference is able to encourage the team to show higher subjective initiative. Especially, a number of managers do not have relevant knowledge, but they still interfere with learning activities…' (captain of miner team of the coal mine A3, 6th July 2011).
Organisational Learning

'…the vision of organisational learning should combine organisational development objectives with members' learning demands, rather than focus only on organisational profit. However, the current situation is that organisational learning focuses on enterprise developing requirements only, and ignores members' learning interests. This vision is good for enterprise, but not supported by staff…The coal mine askes its staff to learn know-how under specific objectives, which have been set up based on organisational profit rather than staff's interest. Therefore, staff has to follow these specific objectives to learn, leading to low learning effectiveness and enthusiasm... The coal mine has a strong desire to absorb know-how in order to promote its technology level, but learning enthusiasm of team members has not been motivated by the organisation and each member only passively follow organisational desire to learn…the state-owned coal mine mainly serves the government, so the organisational goals are always based on governmental objectives rather than enterprise practical requirements and each team's characteristics…' (captain of miner team of the coal mine A3, 6th July 2011)
'…The coal mine has invested sufficiently on R&D to promote knowledge accumulation since 2010, but knowledge accumulation is a long process, we might need to wait a little longer to see effects…' (director of technical department of the coal mine A3, 6th July 2011)
Inter-organisational learning
'…although many coal mines are state-owned, top leaders of each coal mine are not willing to share know-how and experience to others. Because leaders hope to show better performance than other coal mines in order to obtain promotion…' (director of technical department of the coal mine A3, 6th July 2011)

Table 6.3 Interviewees' comments concerning the four categories of learning

6.3 Local State-owned Coal Mines

The Current Situation of the Local State-owned Coal Mine

The coal mine B2, which was established by the local government in 1980, employs 560 employees and has total assets of 52.12 million RMB (around £5 million). Coal mining and transportation within the mine were mainly done manually when it was established. The technology and equipment of the coal mine B2 improved progressively along with Chinese economic development. One interviewee reported the following:

'… From 1980 to 1990, we improved technology and equipment of coal mining, and purchased a number of shearers and excavators, and the degree of mechanization in our mine achieved 30% in early 1990 ... From 1990 to 2000, we continued to invest in improvement of technology and equipment, we also rented some equipment from large state-owned coal mines while we purchased some equipment … until now, our mine has already achieved mechanization…' (general engineer of the coal mine B2, 9th July 2011)

Currently, the coal mine B2 faces challenges from the merging of small private coal mines. The Chinese government is implementing a series of mandatory policies requiring local state-owned coal mines to merge with small coal mines, in order to form new coal groups for improving the technology levels of small coal mines. The policy not only forces state-owned coal mines to merge with small private small coal mines, but also forces local state-owned coal mines to improve the technology and equipment of the small coal mines after the merger. However, small coal mines have thin coal seams and complex geological conditions. Large state-owned coal mines always abandon these types of coal seams, because the cost of mining them is very high. Moreover, thin coal seams and complex geological conditions make it difficult for small coal mines to adopt mechanized mining. Therefore, small coal mines are a burden for local state-owned coal mines, as one interviewee reported:

'… local state-owned coal mines are unwilling to merge with small coal mines, and small coal mines are like a time bomb for managers. Once small coal mines have any accident, we will be deposed … our mining cost will also increase after merge, and R&D investments have to be reduced'(general manager of the coal mine B2, 9th July 2011).

In addition, gas problems are another challenge faced by the local state-owned coal mine, which is a similar problem to that of the large state-owned coal mine. Interviewees stated that the gas problems should be solved through transferring foreign CBM drainage technologies, but they also mentioned that they lacked the funding to transfer and absorb of this technology, as the following interviewee reported:

'… Safety problem is a major challenge that we are facing now … Safety problem mainly focuses on gas explosion and flooding accident … we hope to strength management and import foreign CBM drainage technology in order to ensure safe production, but the cost of importing foreign technology is too high … our production scale is small and may not undertake this high cost. Currently we adopted the CBM drainage technology from large state-owned coal mines. Although their technology is not the best, but the use-cost can be accepted …' (general manager of the coal mine B2, 9th July 2011).

One interviewee further commented on the current managerial situation of the coal mine B2 in the following statement:

‘… The current management condition is better than past, but it still needs to be improved in many aspects … such as top managers should lead by example and pay more attention to miners complying with safe regulations in order to ensure safe production in underground … at the same time, top managers should punish the behaviors of violating safe regulations’ (captain of miner team of the coal mine B2, 6th July 2011).

The observation and interview data revealed that lack of funding and professional technicians made it difficult for the local state-owned coal mine to engage in ITT.

The Understanding of ITT by the Local State-owned Coal Mine

Interviewees from the coal mine B2 considered ITT as a technology trade, in which the transferee purchases the technology from the transferor. Most interviewees stated that their technology level would be improved if they had enough funding, since money can buy more advanced technologies from foreign countries, as commented upon by the following interviewee:

‘… As long as our mine has enough funding, we will gain advanced technologies… the main reason of our lower technology level is lack of enough funding …’(general manager of miner team of the coal mine B2, 6th July 2011).

This author argues that an ITT is not only a transfer of hardware, but also of software. In other words, an ITT is the transfer of a knowledge system. Although money can purchase technology, it cannot buy knowledge. Technology can only be gained by learning. This data also revealed that the concept of knowledge transfer has not been understood appropriately by the chief managers in the coal mine B2. Their understanding of ITT is still thin.

The Necessity of ITT in the Local State-owned Coal Mine

As revealed, safety problems are faced by the coal mine B2. Most interviewees believed that strengthening management and promoting technology levels could solve this problem effectively. Promoting technology levels alone will not solve safety problems if a coal mine does not implement strict safety management and supervision regulations. Guaranteeing safe production is a systematic process and requires many aspects put together to achieve a real sense of safety. It cannot achieve its expected result if a coal mine only depends on ITT. Moreover, the improvement of software (management and technology) is more important than the promotion of hardware (machine and equipment), and both should work together in order to solve safety problems.

Lack of sufficient funding is another problem faced by the coal mine B2 while engaging in ITT, as reported by one interviewee:

'… Lack of enough funding is a big problem that our mine is facing when we hope to gain foreign technology through ITT …'(general manager of the coal mine B2, 6th July 2011).

Based on this situation, it is therefore argued that ITT is useful in promoting the technology levels of the coal mine B2. However, the coal mine B2 is unable to meet the conditions of ITT.

The Current Situation of ITT in the Local State-owned Coal Mine

The interview data revealed that the coal mine B2 had transferred a few foreign technologies in recent years, as reported:

‘… Although our technology is mainly from large state-owned coal mines and other domestic suppliers, about 5% of technology is from foreign suppliers. These technologies are mainly electrical control equipments, such as: jack box … To be honest, foreign technology is better than Chinese technology in performance and quality. But high cost of foreign technology forces us to adopt homemade technology…’ (general manager of the coal mine B2, 6th July 2011)

Although the coal mine B2 transferred a few foreign technologies, the effect of these ITT was still not satisfactory, as the following interviewee commented:

‘… We spent a lot of money to buy foreign technology through ITT in recent years, but it is very difficult for us to absorb the transferred technology…sometimes, our inappropriate operation makes the transferred technology out of service … Finally, we have to abandon foreign technology and re-adopt domestic technology... ‘(general engineer of the coal mine B2, 6th July 2011)

In investigating the reasons that caused this situation, it was found that the technicians of the coal mine had to wait for foreign experts to repair the equipment if it is out of service. Although local technicians endeavored to solve this problem through reading the equipment instructions, they were unable to understand the English instructions. Even though translators were employed, local technicians were still unable to understand how each part of the technology worked. Because their technology capability is low, it is very difficult for them to understand know-how involved in transferred technology. As one interviewee reported:

‘…Comparing with large state-owned coal mines, our production scale is relatively small and may not afford the high cost … the low educational level of miners made them very difficult to absorb foreign advanced technology. 95% of the miners did not understand English. 90% of managers are not good at English … Language barrier is a big problem in learning foreign technology…’ (general manager of the coal mine B2, 6th July 2011)

Therefore, the local state-owned coal mine preferred to adopt domestic technology in order to avoid investment risks and language problems.

How Foreign Technology is Transferred to the Local State-owned Coal Mine

The results of interview revealed that the main channels for ITT in the coal mine B2 are through licensing and importing equipment. The process is similar to that of the coal mine A3. Firstly, they look for appropriate technology after identifying their technology requirements, and begin to negotiate and sign a contract with transferors after finding appropriate technology. Once the two parties sign the contract, the coal mine B2 begins to use the transferred technology; the transferor provides further technical assistance at the same time, as the following interviewee reported:

‘… licensing and purchase of equipments are main methods to promote our technology level, we also hope to set up joint venture with foreign enterprises in order to establish our own R&D center… but the relevant policy limited foreign company to invest in the coal mining industry, that is why it is very difficult for us to attract foreign investment …’ (director of technical department of the coal mine B2, 6th July 2011)

Factors Influencing the Effectiveness of ITT

There are three main factors affecting ITT in the coal mine B2. The first one is the lack of sufficient funding to digest and absorb transferred technology, as reported:

'…Funding already became a main factor affecting ITT …it is very difficult for us to engage in ITT with insufficient funding …' (director of technical department of the coal mine B2, 6th July 2011)

Secondly, lack of talented individual is another factor, as the following interviewee commented:

'…Insufficient funding and weak working environment make us very difficult to attract relevant talented individuals …' (general manager of the coal mine B2, 6th July 2011)

Thirdly, insufficient funding and lack of talented individuals have created a technology gap between transferors and the coal mine B2, which make it very difficult to learn and absorb transferred technologies.

6.4 Small-scale Township and Village Coal Mine

The Current Situation of the Small Coal Mine

The coal mine C5, which was established by private owners in June 1993, has 320 employees and total assets of 21 million RMB (about £2 million). In China, large state-owned coal mines have access to the best coal resources. In contrast, small coal mines can only mine the leftovers bits and pieces of coal seams, which are not willingly mined by large state-owned coal mines. Because the mining conditions of these coal resources are extremely complex, the risks of mining and investment are very high. Generally speaking, the coal resources of small mines are shallow coal seams, which are only mined through manual drilling machines and pickaxes. Miners work in very narrow underground tunnels, in which this researcher crawled forward inch by inch while visiting the small coal mine. Owing to the narrow underground tunnel, large mining equipment is not used in the small coal mine.

This raises the issue of why shallow coal seams are still mined in China, but not in the US or Australia. It was found that this is due to China's rapid economic growth, which requires a large amount of coal in order to ensure the generation of electricity and steel-making. China imported about 160 million tons of coal from foreign coal companies to support its rapid economic development in 2010. Since the Chinese government is unwilling to invest a large amount of money in state-owned coal enterprises for mining these leftover bits and pieces, the government therefore permits individuals to mine the shallow coal seams. Private investors aim to obtain more profit, and it is impossible for them to invest a large amount of money to buy advanced technology and equipment. The private owner of the small coal mine spends as little as possible to buy the most basic equipment, and it was discovered during the observation that only lamps and electric drills are used by miners.

Interviewees at the coal mine C5 stated that management is the main challenge, as miners usually violate operating rules. More than 80% of miners are migrant workers, and most of them come from poor areas. Their educational level is relatively low. One interviewee made his point by using a story to elaborate on the reasons why management is a main challenge in the small coal mines, as recorded below:

"One day, the general manager went to underground tunnel for an inspection of safety production, and he randomly tested safety awareness of the miners. He gave those miners a paper listed with some questions in order to ask about safety production. The following are the conversation:

The manager asked one miner: “why not answer the questions?”

The miner replied: “I do not know a word.”

The manager said “how do you work if you do not know a word?”

Then the miner answered: “why I work here if I know a word.” (According to the captain of miner team of the coal mine C5, 10th July 2011)

Since most of the miners are illiterate, their safety awareness is poor and they often violate safety regulations. Through observations and interviews, it was also found that a number of managers violate safety regulations as well by giving wrong commands to the miners. In addition, most miners in the small coal mine work on a temporary basis and have not signed any contract with their boss. More seriously, the miners are unable to get reasonable compensation if any accident occurs. Although the managers of these small coal mines were asked to sign a formal employment contract with the miners, they refused to do so. These miners are working in a high-risk environment in which many of their basic rights cannot be guaranteed. Therefore, this conflict between managers and miners seriously affects their working enthusiasm. This researcher argues that the government should force the small coal mines to sign a formal employment contract with the miners; the small coal mines should also provide safety production training to its managers and miners in order to improve mismanagement.

The Understanding of ITT by the Small Coal Mine

Since ITT are understood as a technology trade, the interviewees of the coal mine C5 believed that it would able to buy advanced technology and its technology level will be promoted only if it had the sufficient funding.

It was therefore assumed that workers at the coal mine C5 do not understand the essence of ITT. It is clear that both the coal mine B2 and the coal mine C5 have a similar understanding of ITT. They believe that technology is acquired through purchasing rather than learning. Although it is agreed that sufficient funding is able to enable and improve ITT, it is not the crucial factor to achieve a good ITT effect. If technology can be only gained through purchasing, the large state-owned coal mines should have the most advanced technology in the world. In fact, a number of the large state-owned coal mines purchased only technology but did not obtain the know-how involved in the transferred technology. This put the large state-owned coal mines into a vicious circle of transfer - fall behind - transfer again - fall behind again. If the managers of the small coal mines are not able to change their understanding of ITT, they will fall into this vicious circle even if they have sufficient funding.

The Necessity of ITT in the Small Coal Mine

Since the coal mine C5 lacks sufficient funding to engage in ITT, interviewees believe that strengthening management is more effective than engaging in ITT in order to solve gas problems, as the following interviewee commented:

'…Management and technology problem are main challenges that we are facing now … strengthening management is more urgent to us … management problem mainly focuses on three points … firstly, miners violate safety rules … secondly, a number of managers also violate safety regulations … thirdly, some captains of mining teams have not fully supervised miners …' (general manager of the coal mines C5, 10th July 2011)

The Current Situation of ITT in the Small Coal Mine

Most technologies in the coal mine C5 are obtained from domestic suppliers, because their production scales do not cost as much as foreign technology; most of its miners are illiterate, and 99% of managers and miners did not understand English. Insufficient funding, low educational level and weak language skill make it difficult for the small coal mine to engage in ITT.

How Foreign Technology is Transferred to the Small Coal Mine

ITT channels in the coal mine C5 mainly focus on purchasing technology and equipment, and rarely adopt licensing due to the cost. The ITT process of the coal mine C5 shares a number of similarities with the coal mine B2. Firstly, the mine identifies its technology requirement and looks for appropriate technology in domestic market. If the domestic market cannot provide the needed technology, the coal mine C5 will look for the technology on the international market. It will negotiate and pay fees to transferors once it has found the appropriate technology on the international market. The transferor will provide further technical assistance after the coal mine C5 paying the fee.

Factors Influencing the Effectiveness of ITT

Lack of sufficient funding and of talented professionals are two main factors affecting ITT of the coal mine C5, as shown in the following comments of an interviewee:

'…Lack of funding and talented individuals have already become two main factors affecting our ITT …In addition, weak working environment also makes us very difficult to attract talented individuals …' (general engineer of the coal mine C5, 10th July 2011)

Based on these findings, this author argues that the small coal mines are not qualified to engage in ITT, due to their lack of sufficient funding and talented professionals, which can lead to an ineffective ITT.

6.5 Chapter Summary

To sum up, safety and management problems are the main challenges faced by the Chinese coal mining industry. The safety problems mainly concentrate on the ways to solve gas problems through ITT, whereas management problems focus on the ways to reduce dangerous behaviors, such as violating safety regulations, and the ways to digest and absorb transferred technology effectively through scientific technology management and learning.

Since the large state-owned coal mine has a longer mining history and the miners need to mine deeper coal seams, the difficulty of mining has increased in recent years. Deeper coal seams have more complicated geographical structure, such as higher gas concentration and frequent gas outburst. It forces large state-owned coal mines to drain methane from deeper coal seams in order to reduce their gas concentration. However, Chinese domestic technology can only drain methane from shallow coal seams. To solve the gas problem, the large state-owned coal mine must transfer foreign CBM drainage technology. In addition, interview data further revealed that technology management and organisational learning of the large state-owned coal mine is chaotic and badly managed.

It was also found that both the local state-owned coal mine and small coal mine hoped to solve this gas problem through ITT and strengthening safety management, but both the local state-owned coal mine and the small coal mine lack the finances to engage in ITT. Moreover, their current technology capabilities make it difficult for them to digest and absorb the foreign technology.

Furthermore, observation and interview data showed that small coal mines must merge with state-owned coal mines under a new national policy, indicating that small coal mines might disappear after two or three years in China. Therefore, this author argues that further research should focus on large state-owned coal mines. Based on the findings of observations and interviews, it is also clear that the government, organisational technology management, individual, team, organisational and inter-organisational learning are the six main dimensions which influence ITT effectiveness in large state-owned coal mines.

Chapter Seven – Finding from the Survey

7.1 Introduction

This chapter addresses the analysis of the questionnaire data and the statistical validation of its hypotheses. An overview of quantitative data analysis is presented in section 7.1, and the characteristics of respondents are analysed in section 7.2. In section 7.3, the researcher conducts multiple linear regression analyses to examine the causal relationship between a single dependent variable, effects of ITT, a set of explanatory variables, and various affecting factors. The multiple linear regression models focus on identifying variables that can influence the effectiveness of ITT, in order to enable the researcher, policy-makers and coal mine managers to utilize the model and acquired parameters to evaluate the effect of ITT. At the same time, significant indicators will be compared with previous studies, and the analysed results will be explained and elaborated upon. In section 7.4, the researcher tests hypotheses and discusses results. Finally, results and findings are concluded in section 7.5.

Chapter two, chapter three, chapter five and chapter six present a comprehensive and holistic perspective on various factors affecting ITT. Figure 7.1 showed the theoretical framework of current research. The framework presents various constructs, and each construct includes a number of perspectives tested in the survey in order to explore and answer the main research question:

What are the main factors that influence the effectiveness of ITT in the Chinese coal mining industry?

Figure 7.1 Theoretical Framework of Current Study.

This study received 629 questionnaires in total through web-based survey, 5 of which were incomplete, with some missing answers and blank pages. 9 questionnaires were not valid because the respondents have not engaged in licensing. In addition, 27 questionnaires are from transferors and 5 questionnaires from others; owing to the fact that this study focuses mainly on the transferee's standpoint rather than the transferor's, 46 questionnaires were considered to be out of scope for correlation analysis. 583 questionnaires were valid for further quantitative analysis.

The latest version of IBM SPSS 20 has been used to analyse enormous amounts of quantitative data. 54 items were tested by multiple stepwise regressions in order to understand the causal relationship between the affecting factors and ITT effect, and these items have been categorised into eight constructs as presented in Table 7.1. Six of these eight constructs will be developed as hypotheses and will be analysed and tested later in this chapter. In addition, frequency, mean and standard deviations were used for further analysis.

Characteristics of Coal Mine	Output of coal mine
	Location of coal mine
Transferor's performance	Transferor fulfilled the contractual obligation
	Transferor has good cooperation with transferee
Government	The government made innovation strategy to guide the organisation.
	The government made policies to encourage the organisation to learn know-how for innovation through licensing.
	The government made polices, encouraging universities and state research institutes to assist the organisation to absorb know-how.
	The government made polices to encourage the organisation to invest sufficiently in R&D.
	The government made relevant regulations to safeguard the organisation to engage in licensing.
	The government made policies to encourage the development of professional TT agencies to serve the organisation.

	The government has provided financial support when my organisation was engaging in licensing.
	The government made systematic regulations to protect the IPR.
	The government punished severely IPR violation to safeguard profit of transferors.
	The government built an appropriate educational system to supply talented individuals for my organisation to engage in licensing.
Organisational Technology Management	The organisation has a special department responsible for the licensing.
	The organisation made innovation strategies before licensing.
	The organisation built atmosphere of learning new knowledge.
	The organisation arranged professional staff to be responsible for IPR protection of transferors.
	The organisation arranged appropriate individuals to manage the process of licensing.
	The organisation arranged sufficient financial resources to support licensing.
	The organisation built good knowledge communication system for learning.
	The organisation built good discussion forums for learning.
	The organisation provided relevant training.
	The organisation arranged professional staff to select technology.
	The organisation invited external professionals or agencies to select technology.

	The organisational technology management played a positive role in the process of licensing.
Individual Learning	The organisation built good rewarding system to encourage individual learning.
	I have been effectively managed to learn know-how under specific objectives.
	I am willing to learn the know-how.
	I am willing to share the learning experience with my team.
	I and the team have common goals.
	I have a clear learning motivation.
	I have the capability to learn.
	The organisation pays attention to individual learning in the process of licensing.
Team Learning	I am willing to learn the know-how by team units
	The team members and I regularly share the learning progress.
	The team leaders rewarded me when I obtained some learning progress.
	The members of my team have the capability to learn.
	My team and organisation have common goals.
	I am not afraid to display ignorance.
	The team managers regularly participates in our know-how learning.
	The organisation has good team learning in the process of licensing.
	The organisation has a good vision for learning.

Organisational Learning	The organisation has knowledge background to learn.
	The organisation is willing to share knowledge with my team.
	The organisation has a strong desire to absorb know-how.
	The organisation invested sufficiently in R&D to promote knowledge accumulation.
	Middle managers participate regularly in the activities of learning.
	The organisational learning has been given enough attention during the process of licensing.
Inter-organisational Learning	The organisation learns the successful licensing experience from other organisations.
	The organisation shares the experience with other organisations.
	The organisation gains external support from other organisations.
	Top managers participate regularly in the activities of learning.
	The inter-organisational learning has been given enough attention within the organisation.

Table 7.1 Interpretation of Factors

7.2 Descriptive Statistic of Samples: Characteristics of Respondents

The personal characteristics of respondents are analysed in this section, taking data from 583 respondents. In order to investigate the characteristics of respondents, the researcher recorded the duration of their working and licensing experience, the number of engaged licensing projects they have worked on, and their positions. The duration of working was separated into categories of less than 1 year, 1-3 years, 3-5 years, 5-10 years or more than 10 years. The duration of licensing experience was separated into categories of less than 6 months, 6-12 months, 1-3 years, 3-5 years, more than 5 years or none. In addition, the number of engaged licensing projects worked on were divided into categories of none, 1, 2, 3 or more than 3. Respondents were characterised as general manager, general engineer, deputy general manager, director, technician, team leader of miners, or others.

The above four items have been designed to examine whether the collected questionnaires are valid and can be adopted for further data analysis. The examining process is essentially a filtering out of non-target respondents, and it allows the researcher to understand which questionnaires can be adopted for further analysis and which questionnaires should be eliminated. The filtering process is able to identify and delete irrelevant respondents in order to make results more accurate. For example, the researcher found that 9 questionnaires were not valid through filtering, since these respondents had not engaged in licensing.

Table 7.2 presents the statistical results of respondents' working duration; it shows that 71.9% of respondents have worked for more than 10 years in the coal mining industry.

q1 time working in the coal mine industry

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	less than a year	22	3.8	3.8	3.8
	1-3 years	29	5.0	5.0	8.7
	3-5 years	32	5.5	5.5	14.2
	5-10 years	81	13.9	13.9	28.1
	more than 10 years	419	71.9	71.9	100.0
	Total	583	100.0	100.0	

Table 7.2 statistical results of respondents' working length

Table 7.3 presents the statistical results of respondents' licensing experience; 61.4% of respondents have 3-5 years licensing experience.

q2 experienced in licensing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	less than 6 months	32	5.5	5.5	5.5
	6-12 months	36	6.2	6.2	11.7
	1-3 years	126	21.6	21.6	33.3
	3-5 years	358	61.4	61.4	94.7
	more than 5 years	31	5.3	5.3	100.0
	Total	583	100.0	100.0	

Table 7.3 statistical results of respondents' licensing experience

Table 7.4 presents the number of licensing projects the respondents have engaged in, 73.1% of respondents have engaged in more than 3 licensing projects.

q3 engage in project of licensing

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	13	2.2	2.2	2.2
	2	45	7.7	7.7	9.9
	3	99	17.0	17.0	26.9
	more than 3	426	73.1	73.1	100.0
	Total	583	100.0	100.0	

Table 7.4 statistical results of respondents engaged licensing projects

Table 7.5 presents the statistical results of respondents' positions. 66.2% of respondents are technicians.

q4 present post

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	general manager	28	4.8	4.8	4.8
	general engineer	28	4.8	4.8	9.6
	director	63	10.8	10.8	20.4
	technician	386	66.2	66.2	86.6
	team leader of miner	48	8.2	8.2	94.9
	other	30	5.1	5.1	100.0
	Total	583	100.0	100.0	

Table 7.5 statistical results of respondents' positions

Analysis of the above four items shows that most respondents have the following characteristics:

- Have more than 10 years working experience in coal mining industry
- Have 3-5 years licensing experience
- Have engaged in at least 3 licensing projects
- Serve as technicians

These results show that our respondents provided reliable data, which can be used for further analysis.

7.3 Factors Influencing the Effectiveness of ITT

The objective of this section is to explore the causal relationship between ITT effectiveness and various affecting factors in order to answer the main research question, i.e. which factors influence the effectiveness of ITT. Schleirfer and Bell (1995) state that regression analysis is one of the most efficient tools to analyse causal relationships between dependent variables and independent variables, in order to develop a forecast of the future based on the past. Hair et al (1995) further point out that multiple regression equations based on the value of independent variables could be used to predict the value of a single dependent variable. This study adopted multiple regressions to analyse the causal relationship between a single dependent variable (ITT effect) and various independent variables (affecting factors). Wang and Jain (2003) state that when a number of independent variables are recommended as candidates for multiple regression equation, researchers can utilize stepwise regression to select the best set of independents variables for the equation. As the objective of this study is to assist coal mine managers to make maximal predictions about what factors affecting ITT effect, stepwise regression is therefore an appropriate method for achieving this research objective.

The researcher runs scatter plot matrices before performing a multiple linear regression in order to determine if there are linear relationships between a single dependent variable (ITT effect) and various independent variables (affecting factors). The scatter plot matrices showed that there were linear relationships between a single dependent variable and various independent variables.

The following is the multiple linear regression equation:

$$Y\ (\text{ITT Effect}) = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{11}X_{11} + \beta_{12}X_{12} + \beta_{13}X_{13} + \beta_{14}X_{14} + \beta_{15}X_{15} + \beta_{16}X_{16} + \beta_{17}X_{17} + \beta_{18}X_{18} + \beta_{19}X_{19} + \beta_{20}X_{20} + \beta_{21}X_{21} + \beta_{22}X_{22} + \beta_{23}X_{23} + \beta_{24}X_{24} + \beta_{25}X_{25} + \beta_{26}X_{26} + \beta_{27}X_{27} + \beta_{28}X_{28} + \beta_{29}X_{29} + \beta_{30}X_{30} + \beta_{31}X_{31} + \beta_{32}X_{32} + \beta_{33}X_{33} + \beta_{34}X_{34} + \beta_{35}X_{35} + \beta_{36}X_{36} + \beta_{37}X_{37} + \beta_{38}X_{38} + \beta_{39}X_{39} + \beta_{40}X_{40} + \beta_{41}X_{41} + \beta_{42}X_{42} + \beta_{43}X_{43} + \beta_{44}X_{44} + \beta_{45}X_{45} + \beta_{46}X_{46} + \beta_{47}X_{47} + \beta_{48}X_{48} + \beta_{49}X_{49} + \beta_{50}X_{50} + \beta_{51}X_{51} + \beta_{52}X_{52} + \beta_{53}X_{53} + \beta_{54}X_{54} + \varepsilon$$

Notes: β_0 = constant; β_n = regression coefficient for the predictor; independent variables = various affecting factors; ε = error constant arising from the prediction values and the actual observed values, which are subjected to variability and cannot be expressed as an exact linear relationship.

Dependent Variable	
Y	ITT effect.
Independent Variables	
X_1	Output of coal mine.
X_2	Location of coal mine.
X_3	Transferor fulfilled the contractual obligation.
X_4	Transferor has good cooperation with transferee.
X_5	The government made innovation strategy to guide the organisation.
X_6	The government made policies to encourage the organisation to learn know-how for innovation through licensing.
X_7	The government made policies, encouraging universities and state research institutes to assist the organisation to absorb know-how.
X_8	The government made policies to encourage the organisation to invest sufficiently in R&D.
X_9	The government made relevant regulations to safeguard the organisation to engage in licensing.
X_{10}	The government made policies to encourage the development of professional TT agencies to serve the organisation.
X_{11}	The government has provided financial support when my organisation was engaging in licensing.
X_{12}	The government made systematic regulations to protect the IPR

X_{13}	The government punished severely IPR violation to safeguard profit of transferors.
X_{14}	The government built an appropriate educational system to supply talented individuals for my organisation to engage in licensing.
X_{15}	The organisation has a special department responsible for the licensing.
X_{16}	The organisation made innovation strategy before licensing.
X_{17}	The organisation built atmosphere of learning new knowledge.
X_{18}	The organisation arranged professional staff to be responsible for IPR protection of transferors.
X_{19}	The organisation arranged appropriate individuals to manage the process of licensing.
X_{20}	The organisation arranged sufficient financial resources to support licensing.
X_{21}	The organisation built good knowledge communication system for learning.
X_{22}	The organisation built good discussion forums for learning.
X_{23}	The organisation provided relevant training.
X_{24}	The organisation arranged professional staff to select technology.
X_{25}	The organisation invited external professionals or agencies to select technology.
X_{26}	The organisational technology management played a positive role in the process of licensing.
X_{27}	The organisation built a good rewarding system to encourage individual learning.
X_{28}	I have been effectively managed to learn know-how under specific objectives.
X_{29}	I am willing to learn the know-how.
X_{30}	I am willing to share the learning experience with my team.

X_{31}	I and the team have common goals.
X_{32}	I have a clear learning motivation.
X_{33}	I have the capability to learn.
X_{34}	The organisation pays attention to individual learning in the process of licensing.
X_{35}	I am willing to learn the know-how by team unit.
X_{36}	The team members and I regularly share the learning progress.
X_{37}	The team leader rewarded me when I obtained some learning progress.
X_{38}	The members of my team have the capability to learn.
X_{39}	My team and organisation have common goals.
X_{40}	I am not afraid to display ignorance.
X_{41}	The team managers regularly participate in our know-how learning.
X_{42}	The organisation has good team learning in the process of licensing.
X_{43}	The organisation has good vision for learning.
X_{44}	The organisation has knowledge background to learn.
X_{45}	The organisation is willing to share knowledge with my team.
X_{46}	The organisation has strong desire to absorb know-how.
X_{47}	The organisation invested sufficiently in R&D to promote knowledge accumulation.
X_{48}	Middle managers participate regularly in the activities of learning.
X_{49}	The organisational learning has been given enough attention during the process of licensing.
X_{50}	The organisation learns the successful licensing experience from other organisations.
X_{51}	The organisation shares experience with other organisations.

X_{52}	The organisation gains external support from other organisations.
X_{53}	Top managers participate regularly in the activities of learning.
X_{54}	The inter-organisational learning has been given enough attention in the organisation.

Table 7.6 Dependent variable and independent variables

Tables 7.7 and 7.8 present the results of analysis, which showed a significant adjusted R square of 0.773 for the correlation between ITT effect and X_1 (coal mine output), X_5(innovation strategy), X_9(relevant safeguard regulations), X_{10}(encouragement policy for development of TT agency), X_{13}(punishing IPR violation), X_{17}(building atmosphere of learning new knowledge), X_{23}(relevant training), X_{31}(common goals), X_{40}(displaying ignorance), X_{41}(team manager participating learning), X_{42}(good team learning), X_{43}(good learning vision), X_{44}(knowledge background), X_{48}(middle managers participating learning). Therefore, these factors are considered to have significantly affected the ITT effect.

The following is a multiple linear regression equation after performing stepwise regression:

$$Y\ (\text{ITT Effect}) = \beta_0 + \beta_1X_1 + \beta_5X_5 + \beta_9X_9 + \beta_{10}X_{10} + \beta_{13}X_{13} + \beta_{17}X_{17} + \beta_{23}X_{23} + \beta_{31}X_{31} + \beta_{40}X_{40} + \beta_{41}X_{41} + \beta_{42}X_{42} + \beta_{43}X_{43} + \beta_{44}X_{44} + \beta_{48}X_{48} + \varepsilon$$

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.516[a]	.266	.265	.80823
2	.640[b]	.409	.406	.72625
3	.701[c]	.491	.487	.67494
4	.750[d]	.563	.558	.62631
5	.794[e]	.631	.626	.57611
6	.813[f]	.660	.655	.55368
7	.822[g]	.676	.670	.54129
8	.844[h]	.713	.707	.51044
9	.844[i]	.712	.706	.51075
10	.855[j]	.732	.726	.49319
11	.862[k]	.743	.737	.48366
12	.869[l]	.754	.748	.47326
13	.874[m]	.764	.757	.46481
14	.878[n]	.770	.763	.45870
15	.881[o]	.775	.768	.45441
16	.884[p]	.781	.773	.44922

Model 16 has been chosen because it has the best adjusted R square (0.773).

Table 7.7 multiple regression analysis of the quantitative research: stepwise regression model analysis

The following is a multiple linear regression equation with coefficients presented in Table 7.8:

$$Y \text{ (ITT Effect)} = 4.215 - 0.325X_1 - 0.205X_5 + 0.103X_9 - 0.122X_{10} + 0.126X_{13} + 0.186X_{17} + 0.173X_{23} - 0.067X_{31} - 0.235X_{40} - 0.180X_{41} + 0.208X_{42} - 0.354X_{43} + 0.350X_{44} - 0.198X_{48} + \varepsilon$$

Coefficients[a]						
Rows 101 through 187 of 187						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
16	(Constant)	4.215	.121		34.903	.000
	q5 output of coal mine in 2010	-.325	.034	-.260	-9.564	.000
	q11 made innovation strategy to guide in licensing	-.205	.028	-.225	-7.221	.000
	q50 organization has good vision for learning the know-how	-.354	.028	-.445	-12.817	.000
	q24 built atmosphere of learning new knowledge	.186	.044	.230	4.242	.000
	q15 made regulations to safeguard organization in licensing	.103	.035	.112	2.913	.004
	q47 I am not afraid to display ignorance in the team learning	-.235	.037	-.302	-6.349	.000
	q51 organization has knowledge background to learn know-how	.350	.068	.437	5.138	.000
	q48 team manager participates in know-how learning	-.180	.035	-.221	-5.189	.000
	q18 made policies to encourage the development of professional technology transfer agent	-.122	.028	-.123	-4.431	.000
	q55 middle managers participate regularly in the activities of learning know-how	-.198	.043	-.233	-4.624	.000
	q49 organization has good team learning	.208	.072	.263	2.897	.004
	q30 provided relevant training for me	.173	.049	.221	3.551	.000
	q17 punished IPR violation to safeguard profit of transferor	.126	.038	.131	3.303	.001
	q38 the team and I have common goals	-.067	.022	-.093	-3.105	.002

Notes: Dependent variable is ITT effect.

Table 7.8 multiple regression analysis: regression model 16 has been chosen

Figure 7.2 presents the positive and negative correlations between ITT effects and influential factors.

Figure 7.2 positive and negative correlations between ITT effect and affecting factors

The variable "Output of coal mine" is the most significant predictor, with a t-value equal to -9.564 and p-value equal to 0.000, and it presents a negative correlation between coal mine output and ITT effects. As the sequence design of ITT effect runs from very good to very poor in the questionnaire, the sequence design of coal mine output is from low to high. Hence, this finding means larger coal mines have better ITT effects. This finding is also consistent with empirical evidence from observation and semi-structured interviews, and it shows that ITT effects of the large state-owned coal mine is better than the local state-owned coal mine and the small coal mine. During the interview process, the managers of the small coal mines and the local state-owned coal mine also mentioned that their output was low, which in turn makes it financially difficult for them to engage in ITT. This is the reason the questionnaire only focuses on large state-owned coal mines rather than small coal mines and local state-owned coal mines.

Moreover, this finding is also consistent with prior studies by Lai and Tsai (2009), which indicated that the scale of enterprise influenced the effects of ITT. It is also consistent with previous studies by Lihua (2001), who investigated ITT in the construction industry of China's three provinces within Sino-foreign joint ventures using a structured survey. Lihua's findings showed significant association between ITT and economic development, which means that ITT is easy to achieve successfully if the transferee's economic development is at the same level as the transferor's. In other words, large scale coal mines have high coal output, and high output means more profit and good economic development. Compared with small scale coal mines, large coal mines have only a small technology gap with foreign transferors, because they are able to invest more funding in R&D and therefore can learn transferred knowledge and achieve better effect more easily than small scale coal mines. In addition, the results of a stepwise regression also revealed that the output of the coal mine was the most important indicator, as it contributes 26.5 percent of the variance to ITT effects.

"Making innovation strategy" is, highly significantly, negatively correlated with ITT effects, with a t-value equal to -7.221 and a p-value equals to 0.000. This finding is consistent with the finding from interview analyses, in which the director of technical department mentioned that the government should draw up strategies of technology innovation in order to encourage coal mines to digest and absorb transferred technology for further innovation. He went on to say that the innovation strategy must be based on the practical situation of coal mines rather than government purposes, and it would restrict the independent innovation and R&D of coal mines if the innovation strategy is only based on government profit.

This finding is inconsistent with previous research studies by Odigie (2012). Odigie studied ITT in indigenous Nigerian construction organisations and his research also shows that there were significant positive associations between technology strategy and ITT effects. This inconsistency is due to the different characteristics of the coal mining and construction industries. Nigerian construction industry is mainly a private and foreign investment enterprise, but the Chinese coal mining industry is mostly a state-owned enterprise serving the government. The government always designs innovation strategies for its own purposes rather than the enterprise's practical situations, and this results innovation strategy negatively affecting ITT effects.

"Making relevant safeguarding regulation" is significantly positively correlated to ITT effects, with a t-value equal to 2.913 and a p-value equal to 0.004. This result is consistent with the findings from interview analyses, in which the general manager stated that government should draw up appropriate policies to enable coal mines to engage in ITT. The finding is also consistent with previous studies by Lai and Tsai (2009), who show that the government should make relevant regulations to safeguard organisations engaging in ITT.

"Making policies to develop TT agencies" is significantly negatively correlated to ITT effects, with a t-value equal to -4.431 and a p-value equal to 0.000. This result is inconsistent with the findings from interview analyses, in which the general manager stated that developing professional TT agencies was an effective way to facilitate ITT, and government should encourage the development of these agencies. However, the finding is consistent with previous research studies by He and Si (2010), which indicates that a number of TT agencies lack professional staff, which determines the service quality of those agencies. ITT is essentially a knowledge transfer that requires many professional staff working together to enable the complex transfer process. This professional staffs include technicians, marketing experts and legal experts, but most Chinese TT agencies lack professional staff. As most enterprises are not well versed in ITT, they have to depend on TT agencies. In addition, current Chinese policies focus only on increasing the number of TT agencies rather than promoting their service quality, resulting in increasing agency numbers is without increasing service quality. Hence, encouraging development of TT agencies has led to the appearance of many low-level agencies, and the government should adjust the relevant policies to promote service quality of agencies rather than increasing blindly the number of agencies.

"Punishing IPR violation to safeguard profit of transferors" is significantly negatively correlated to ITT effects, with a t-value equal to 3.303 and a p-value equal to 0.001. This finding is consistent with findings from interview analyses, in which the general engineer pointed out that IPR protection was vitally important to improve ITT effects. The finding is also consistent with previous research studies by Kirkland (1999), which indicate that the protection level of intellectual property rights was a main factor influencing the effectiveness of ITT. This result reveals that the government should pay more attention to IPR protection.

"Building atmosphere of learning new knowledge" is significantly positively correlated to ITT effect, with a t-value equal to 4.242 and a p-value equal to 0.000. This finding is consistent with the findings from interview analyses, in which the general engineer mentioned that promoting technology levels required enterprises to build an atmosphere conducive to learning new knowledge and create a good learning environment in order to help staff continually and effectively assimilate transferred knowledge. The finding is also consistent with previous research studies by Liao et al (2006), whose research points out that an atmosphere of learning new knowledge is a vital factor affecting knowledge acquisition in the process of knowledge transfer.

"Providing relevant training" is significantly positively correlated to ITT effect, with a t-value equal to 3.551 and a p-value equal to 0.000. This result is consistent with the findings from interview analyses, in which the director of the mining department mentioned that relevant training was very important before ITT, as it is able to help staff understand transferred technology and learn relevant knowledge in order to further digest and absorb transferred knowledge and so to improve ITT effects. The finding is also consistent with previous research studies by Madu (1989), whose research shows that training is a main factor influencing the effectiveness of ITT.

"Common goals" is significantly negatively correlated to ITT effect, with a t-value equal to -3.105 and a p-value equal to 0.002. This result is consistent with the findings from interview analyses, in which the captain of the miner team stated that team goals focused on finishing learning tasks that the top leader distributed to each team, and individual goals focused on finishing a part of the learning task. Since the learning task was distributed passively by the top leader rather than each team selecting tasks following their interests and advantage, easy tasks might be distributed to captains who have a good relationship with the top leader, while difficult tasks might be distributed to captains who have a weak relationship with the top leader. Moreover, the coal mine lacks incentive mechanisms to encourage individuals to finish learning tasks, and individual bonuses are deducted if learning tasks are not finished on time. Although individuals are not interested in the task, they have to keep common goals with their teams. Therefore, formation of common goals between team and staff is passive rather than active. This is why “common goals” is negatively correlated to ITT effect.

“Display ignorance” is significantly negatively correlated to ITT effect, with a t-value equal to -6.349 and a p-value equal to 0.000. This result is inconsistent with previous research studies by Sun and Scott (2005), whose research shows that the effectiveness of knowledge transfers is affected when transferee staffs are worried about inadequate individual knowledge. It means that the item “individual is not afraid to display ignorance in team learning” should be significantly and positively correlated with ITT effects, but analysis of this gave the opposite result. This inconsistent analysis result may be attributed to the difference between the coal mining industry and the consultancy industry.

Sun and Scott’s research was based on empirical research in the consultancy industry. Compared to consultancy industry, knowledge level of staff in coal mining industry is relatively low, as most of them only graduated from middle or high school. Their knowledge level and capability are similar and they are not afraid to display ignorance in team learning. In addition, they often argue that their experience is more useful in team learning than transferred knowledge, and team members can also refuse to accept new knowledge. There may be ones who know nothing but be afraid of nothing, and the learning effect is negatively affected by this unique workplace culture.

“Team managers regularly participates in know-how learning” and “Middle managers participate regularly in the activities of learning” are significantly negatively correlated to ITT effects, with t-values equal to -5.189 and -4.624 and p-values equal to 0.000 and 0.000. This analysis result is consistent with the findings from interview analyses, in which the captain of the miner team stated that managers should not participate or interfere in learning activities too much, as less interference encourages team members to show a higher level initiative. Interference can result especially in weak learning effect, in which managers do not understand relevant knowledge but still interfere in learning activities. The research findings of Blackler and McDonald (2000), Edmondson (2002) and Liao (2006) can explain this analysis result. Blackler and McDonald (2000) analysed the influence of power in an organisation’s learning processes and found out that power plays a vital role in learning effects. Edmondson (2002) further support Blackler and McDonald’s argument by pointing out that power influence how groups and teams learn in an organisation. Liao (2006) also shows that power influences learning in a team. Their research results indicate that the power of managers is a main factor affecting team learning. A manager’s behavior can negatively affect the learning effect if he exercises power inappropriately in learning activities.

“Organisation has good team learning” is significantly positively correlated to ITT effects, with a t-value equal to 2.897 and a p-value equal to 0.004. This result is consistent with the findings from interview analyses, in which the general engineer stated that team learning was an important factor influencing ITT effects. This result is also consistent with previous research studies by Sun and Scott (2005), who argue that there is a significant association between team learning and knowledge transfer.

“Organisation has good vision for learning” is significantly negatively correlated to ITT effects, with a t-value equal to -12.817 and a p-value equal to 0.000. This result is consistent with the findings from interview analyses, in which the captain of the miner team argued that the ideal organisational learning should combine the enterprise development objective with its members’ demand for learning, rather than focusing only on the enterprise’s profit.

However, organisational learning vision is currently only based on the enterprise's developing requirements and ignores its members' learning interests. This type of vision is good for the enterprise, but it is not supported by its staff. This is why it negatively influences ITT effects.

"Organisation has knowledge background to learn" is significantly positively correlated to ITT effects, with a t-value equal to 5.138 and a p-value equal to 0.000. This result is consistent with previous studies by Zhang (2009), which showed that a transferee's original knowledge background would affect the learning of new knowledge, since their original knowledge background is a dynamic and integrated experience system that includes a variety of knowledge.

Excluded Variables[t]

Rows 701 through 800 of 858

Model		Beta In	t	Sig.	Partial Correlation
16	q6 location of coal mine	.033[p]	1.342	.180	.070
	q9 transferor filled the contractual obligation	.039[p]	1.561	.119	.081
	q10 transferor has good obligation in licensing	.006[p]	.241	.810	.013
	q12 encourage organization to learn know-how for innovation	-.059[p]	-1.690	.092	-.088
	q13 encourage university and research institute to absorb know-how	.031[p]	.765	.445	.040
	q14 made policies to invest R & D	-.038[p]	-1.486	.138	-.077
	q16 made systematic regulations to protect the IPR of transferor	.097[p]	1.974	.049	.102
	q19 built appropriate educational system to supply talent for my organization	.082[p]	1.878	.061	.097
	q20 provided financial support	.050[p]	1.780	.076	.092
	q21 have a special department responsible for the licensing?	-.004[p]	-.173	.863	-.009
	q23 organization made innovation strategy before licensing	.034[p]	1.131	.259	.059
	q25 arranged professional staff to be responsible for IPR protection of transferor	.016[p]	.516	.606	.027
	q26 arranged appropriate talent to manage the process of licensing	.039[p]	1.198	.232	.062
	q27 arranged sufficient financial resources to support licensing	.047[p]	.857	.392	.044
	q28 built good knowledge communication system for learning the know-how	.047[p]	1.387	.166	.072
	q29 built good discussion forums for learning the know-how	-.019[p]	-.418	.676	-.022
	q31 arranged professional staff to identify the technology during selecting technology	.066[p]	1.615	.107	.084

Table 7.9 multiple regression analysis. (Non-significant variables were excluded from the regression model.)

Since the variable “location of coal mine” had a t-value of 1.342 and a p-value of 0.180, it was excluded from the regression equation. This means that this factor is not significantly connected to the ITT effect. This result does not coincide with previous research studies by Samli (1985), which shows that geography, economy, culture and technique are the four main factors which must be considered if a transferee hopes to achieve effective ITT. The result is also inconsistent with previous research studies by Al-Thawwad (2008), which indicates that geographical location had a significant association with effectiveness of ITT through surveying Saudi Arabia’s private manufacturing industries.

Both Samli (1985) and Al-Thawwad (2008) state that the question of how geographical locations affect ITT should focus mainly on two aspects. Firstly, transferee in a geographical location lacks necessary material and natural resource to assimilate transferred technology. Secondly, the transferee is in a geographical location which lacks key ingredients to digest and absorb transferred technology.

The inconsistent analysis result may be attributed to the fact that large state-owned coal mines are run on a large scale and produce high output, which means that they also have access to strong financial resources. Even though they lack necessary materials and key ingredients, they are able to obtain these materials and ingredients through purchasing. For example, even though trees are not suitable for planting in Dubai because it is in the desert and water is very valuable, planning officials in Dubai spent $3,000 to plant each tree. This case challenges Samli and Al-Thawwad’s argument. Therefore, in this study geographical location has not been considered as a main factor influencing the effectiveness of ITT in large state-owned coal mines.

Since the variables “transferor fulfilled the contractual obligation” and “transferor has good cooperation with transferee” had t-values of 1.561 and 0.241 and p-values of 0.119 and 0.810, they were excluded from the regression equation. This means that the two factors not significantly connected to ITT effects. This result does not coincide with previous research studies by Lai and Tsai (2009), which indicate that the attitude and performance of transferors are the main factors influencing the effectiveness of ITT. This inconsistent result can be attributed to the fact that large state-owned coal mines pay for their ITT in installments, which requires the transferor to fulfill contractual obligations and cooperate with the transferee in order to obtain total payment.

Since the variable “government made policies to encourage organisation to learn know-how for innovation” had a t-value of -1.690 and a p-value of 0.092, the variable “government made polices, encouraging the university and state research institutes to assist organisation to absorb know-how” had a t-value of 0.765 and a p-value of 0.445, and the variable “government made polices to encourage organisation to invest sufficient R&D” had a t-value of -1.486 and a p-value of 0.138, they were excluded from the regression equation. This means that the three factors are not significantly connected to ITT effects. The researcher is surprised to find the results, which do not coincide with the findings from interview analyses in which the deputy general manager stated that the government should implement relevant policies to encourage coal mines to innovate, invest in R&D and cooperate with universities and state research institutes in order to thoroughly learn know-how. The finding is also inconsistent with previous research studies by Odigie (2012), who studied ITT in indigenous Nigerian construction organisations and who showed that the effect of ITT is affected by relevant government policies encouraging innovation, investment in R&D and cooperation with universities and research institutes.

This inconsistent analysis result can be attributed to the current situation, in which a number of provincial governments have not investigated the real statuses of their coal mines before making relevant policies and the government has not paid adequate attention to coal mines' advice and feedback. The original intention of these polices is to encourage coal mines to learn skills for innovation through ITT, but it is difficult for the government to achieve its expected results (Sun, 2011). Because these unrealistic policies focused only on government profits, these policies have been easily generated but implemented with difficulty. In addition, a number of policies limited coal mines to follow their requirements to learn know-how for innovation. Therefore, the government essentially plays a negative role in current ITT.

Since the variable "government made systematic regulations to protect the IPR" had a t-value of 1.974 and a p-value of 0.049, it was excluded from the regression equation. This means that this factor might be positive and significant to the ITT effect. Since there are multicollinearity problems among the independent variables, this researcher performed a stepwise regression. This means that a number of significant predictors might have been excluded from the regression equation in order to improve the explanatory power of the equation. The analysis result coincides with previous research studies by Kirkland (1999), which indicate that the protection level of intellectual property rights was a main factor influencing the effectiveness of ITT.

Since the variable "government built appropriate educational system to supply talented individual for my organisation to engage in licensing" had a t-value of 1.878 and a p-value of 0.061, it was excluded from the regression equation, yet it may be positive and significant to the ITT effects. This result is consistent with the findings from interview analyses in which the general engineer pointed out that the coal mine lacked sufficient skilled individuals to digest and absorb transferred technology. He believed that the current education system should be improved in order to provide sufficient talented individuals for coal mines to engaging in ITT. This finding is also consistent with previous research studies by Madu (1989), Kirkland (1999), Lai and Tsai (2009), and Jasinski (2009), whose research results showed that educational training, educational situation, manpower skills, staff and skills of transferees all influenced the effectiveness of ITT. Thus, building an appropriate education system could improve these aspects.

Since the variable “government has provided financial support when my organisation was engaging in licensing” had a t-value of 1.780 and a p-value of 0.076, it was excluded from the regression equation, yet it may be positive and significant to the ITT effects. The analysis result is consistent with the findings from interview analyses, in which the deputy general manager pointed out that it would improve ITT effects if the government is able to provide relevant financial support.

Since the variable “organisation has a special department responsible for the licensing” had a t-value of -0.173 and a p-value of 0.863, it was excluded from the regression equation. This means that this factor is not significant to ITT effects. This finding is inconsistent with previous research studies by Debackere and Veugelers (2005) and Macho-Stadler et al (2007), which indicate that it is necessary to set up a special department to be responsible for ITT. This department is able to provide assistance for the organisation to contact transferors or other organisations, and can also coordinate with different departments to achieve harmonious cooperation. In addition, the department’s staff should have extensive licensing experience and be able to deal professionally with any problems which appear in the transfer process and might influence the effectiveness of ITT.

This inconsistent analysis result may be attributed to the fact that the status of the special department in the large state-owned coal mine is relatively low; it occupies a single office and has 2 or 3 staff members. This means that other departments may not pay enough attention to the special department. Licensing is a complex process and needs many departments to cooperate together; it is difficult to achieve a beneficial ITT effect if the other departments do not give sufficient support to the special department in the process of licensing. Therefore, the top leader should give the special department sufficient support and a higher status in order to help it coordinate and cooperate with other departments in the licensing process.

Since the variable “organisation made innovation strategy before licensing” had a t-value of 1.131 and a p-value of 0.259, it was excluded from the regression equation. This means that this factor is not significant to the ITT effect. This finding is also inconsistent with previous research studies by Odigie (2012), who studied ITT in indigenous Nigerian construction organisations and whose research showed that there were positive and significant associations between innovation strategy and ITT effects. The inconsistence might be attributed to the fact that different industries have different characteristics. Enterprises within the Nigerian construction industry are mainly private and foreign investment, and enterprises within the Chinese coal mining industry are mainly state-owned. Chinese coal enterprises essentially serve the government, and the government always designs the innovation strategy of coal enterprises based on its own purpose rather than the enterprise’s practical situation, which leads to the innovation strategies which may be inappropriate and ineffective which attempting to improve ITT effects.

Since the variable “organisation arranged staff to be responsible for IPR protection of transferor" had a t-value of 0.516 and a p-value of 0.606, it was excluded from the regression equation. This means that this factor is not significant to ITT effects. This result is not consistent with previous research studies by Kirkland (1999), which indicate that protection levels of intellectual property rights are a main factor influencing the effectiveness of ITT. This inconsistency can be attributed to the fact that China lacks professional IPR protection individuals, the entire country has only about two thousand qualified individuals who are able to engage in IPR protection (Mao, 2012). Coal mines have arranged staff responsible for IPR protection, but most of them have not earned qualifications at the professional level. The analysis result is consistent with the findings from interview analyses, in which the general manager pointed out that the current education system results in a lack of qualified staff and talented individuals responsible for IPR protection in coal mines.

Since the variable "organisation arranged talented individual to manage the process of licensing" had a t-value of 1.198 and a p-value of 0.232; it was excluded from the regression equation. This means that this factor is not significant to ITT effects. This finding is inconsistent with previous research by Madu (1989), which indicated that management was a main factor affecting ITT. This inconsistency can be attributed to the fact that organisations arrange for talented individuals to manage the licensing process, but these individuals are not good at technology management. The findings from interview analyses support this inference. The general manager stated that large state-owned coal mine had a number of managers who were good at business management, but business management and technology management are two completely different things. Chinese coal mines lack individuals who are good at technology management.

Since the variable "organisation arranged sufficient financial resources to support licensing" had a t-value of 0.857 and a p-value of 0.392, it was excluded from the regression equation. This means that the factor is not significant to ITT effects. The result is consistent with the findings from interview analyses. The director of the technical department pointed out that sufficient finances were able to help enterprises buy technology, but money could not assist coal mines to achieve good ITT effects, and technology levels in China's coal mining industry would be the highest in the world if money were able to buy knowledge.

Since the variables "organisation built good knowledge communication system for learning" and "organisation built good discussion forums for learning" had t-values of 1.387 and -0.418 and p-values of 0.166 and 0.676, they were excluded from the regression equation. This means that both factors are not significant to ITT effects. The finding is inconsistent with previous studies by Kirkland (1999), Lai and Tsai (2009), and Jasinski (2009), whose research indicates that the systems and channels of communication were two main factors affecting ITT. This inconsistency may be attributed to the fact that good communication systems and discussion forums need a number of "gatekeepers", who are not only able to assimilate transferred knowledge but also to transform external know-how into internal knowledge which staff can understand through "gatekeepers" sharing it (Owens, 2012). However, the director of the technical department pointed out that the large state-owned coal mine lacks "gatekeepers". He suggested that large state-owned coal mine should recruit more "gatekeepers" to improve the effects of communication learning.

Since the variable "organisation arranged professional staff to select technology" had a t-value of 1.615 and a p-value of 0.107, it was excluded from the regression equation. This researcher is surprised to find that this factor might not be significant to ITT effects. Since its p-value is 0.107, which is slightly larger than 0.1, there might be an error affecting the analysis result. The researcher argues that this factor may still be positive and significant to the ITT effect. The result is consistent with the findings from interview analyses, in which the general engineer pointed out that his organisation should arrange for professional staff to select the technology before the transfer, in order to guarantee that the transferred technology is appropriate for the coal mine.

Excluded Variables[t]

Rows 701 through 800 of 858

Model	Beta In	t	Sig.	Partial Correlation
q32 invited external professionals or agents to identify technology during selecting technology	-.043[p]	-1.027	.305	-.053
q33 played a positive role in the process of licensing	.055[p]	1.435	.152	.074
q34 built good rewarding system to encourage my learning of the know-how	.035[p]	.889	.375	.046
q35 I have effectively managed to learn know-how under specific objectives	.010[p]	.312	.755	.016
q36 I am willing to learn the know-how	-.025[p]	-.735	.463	-.038
q37 I am willing to share the learning experience with my team	-.015[p]	-.406	.685	-.021
q39 I have the clear learning motivation	.045[p]	.965	.335	.050
q40 I have the capability to learn know-how	-.021[p]	-.637	.525	-.033
q41 organization pays attention to individual learning	.014[p]	.279	.780	.015
q42 I am willing to learn the know-how by team unit	-.093[p]	-2.137	.033	-.110
q43 team members and I regularly share the learning progress	.027[p]	.648	.518	.034
q44 team leader rewarded me when I obtained some learning progress	.071[p]	.916	.360	.048

Table 7.10 Non-significant variables were excluded from the regression model.

Since the variable "organisation invited external professionals or agencies to select technology" had a t-value of -1.027 and a p-value of 0.305, it was excluded from the regression equation. This means that this factor is not significant to ITT effects. This result is inconsistent with the findings from interview analyses, in which the deputy general manager stated that the coal mine hoped to invite external agencies to help select technology before ITT took place. This finding is also consistent with previous studies by He and Si (2010), which indicate that a number of Chinese TT agencies lack professionals, who determine service quality of the agencies. It is not possible to improve the effectiveness of ITT if enterprises depend on unqualified agencies to select technology. However, China's coal enterprises have to depend on these unqualified agencies because most coal mines are not good at doing ITT.

Since the variable "organisational technology management played a positive role in the process of licensing" had a t-value of 1.435 and a p-value of 0.152, it was excluded from the regression equation. This researcher is surprised to find that this factor might be insignificant to the ITT effect. This result is inconsistent with the findings from interview analyses, in which the general manager stated that technology management played an important role in the ITT process. The researcher used a stepwise regression, this item had a t-value of 2.375 and a p-value of 0.018 when the researcher had chosen Model 13 with adjusted R square 0.757. Comparing model 16 with model 13, the adjusted R square has only grown from 0.757 to 0.773. In addition, there is multicollinearity among independent variables, so there might be errors affecting accuracy of the analysis result. Therefore, this researcher argues that this item might be positive and significant to the effect of ITT.

Since the variables "organisation built good rewarding system to encourage learning" and "the team leader rewarded me when I obtained some learning progress" had t-values of 0.889

and 0.916 and p-values of 0.375 and 0.360, they are excluded from the regression equation. This means that both factors are not significant to ITT effects. This finding is inconsistent with previous studies by Campbell (2007) and Ganguli et al (2009), which indicates that the development of a good reward system facilitates ITT. The finding is consistent with previous research by Pink (2009), who argues that although many researchers consider carrot-and-stick or rewards and punishment approach to be a very effective way to motivate staff, this is a mistake. Reward and punishment is able to motivate staff when they face simple work, but might not be an effective way when they face complex work. Learning transferred knowledge is a very complex process, and a single reward system might not improve the effects of learning.

Since the variable "I have been effectively managed to learn know-how under specific objectives" had a t-value of 0.312 and a p-value of 0.755, it was excluded from the regression equation. This means that this factor is not significant to ITT effects. This finding is consistent with previous research by Cao (2005), who states that improving learning effects can be achieved by motivating the staff's 'learning enthusiasm rather than managing them under specific objectives, and enterprises should change the way of management from "want staff to learn" to "staff want to learn".

Since the variables "I am willing to learn the know-how" and "I have the clear learning motivation" had t-values of -0.735 and 0.965 and p-values of 0.463 and 0.335, they were excluded from the regression equation. It means that both factors are not significant to ITT effects. This finding is inconsistent with previous research by Bigge and Hunt (1980), who state that individual willingness and motivation are important factors affecting ITT. Based on Bigge and Hunt's theory, "I am willing to learn the know-how" should have a positive and significant correlation with ITT. This inconsistency might be attributed to a fact mentioned by the captain of miner team: that the coal mine asked staff to learn know-how under specific objectives which had been set up based on organisational profit rather than staff's interest. Staffs have to follow specific objectives to learn and their bonus will be reduced if they are not willing to learn the know-how: this leads to very low learning effectiveness and enthusiasm.

Since the variables "I am willing to share the learning experience with my team", "the team members and I regularly share the learning progress" and "organisation is willing to share knowledge with my team" had t-values of -0.406, 0.648 and -0.210 and p-values of 0.685, 0.518 and 0.833, they are excluded from the regression equation. It means that these three factors are not significantly connected to ITT effects. This finding is inconsistent with previous research by Hall (2001, p. 19), who argues that ''knowledge creates knowledge only when it is shared''. A good ITT effect may be achieved when teams and members share sufficient knowledge in the process of learning. This inconsistent result might be attributed to a fact mentioned by the director of the technical department: that there is very huge competition pressure among staff and each one is worrying others learning more know-how than themselves in the sharing process. Individuals are able to perform better if they have acquired more know-how, and it assists them in obtaining more opportunity for promotion. Members also shared learning experience and progress with other members, but they only share explicit knowledge rather than tacit knowledge. Mair (2004) states that staff members are not willing to share the know-how they have unless there is a strong incentive. Moreover, individual sharing is a precondition of organisational and team sharing, and organisational and team sharing is insignificant if individuals only share common knowledge rather than valuable know-how.

Since the variables “I have the capability to learn” and “the members of my team have the capability to learn” had t-values of -0.637 and 1.076 and p-values of 0.525 and 0.283, they were excluded from the regression equation. It means that both factors are not significantly connected to ITT effects. This finding is inconsistent with previous research by Lai and Tsai (2009), which found that personal knowledge and educational situations were important factors affecting ITT. The inconsistency might be attributed to a fact mentioned by the director of technical department: that most staff members had the capacity to learn, but their learning is not conducted in a shared environment. Therefore, the two factors will not significantly improve the effects of ITT.

Since the variable “organisation pays attention to individual learning in the process of licensing” had a t-value of 0.279 and a p-value of 0.780, it was excluded from the regression equation. This means that this factor is not significantly connected to ITT effects. This finding is inconsistent with previous research by Sun and Scott (2005), which shows that individual learning affects knowledge transfers. This inconsistency might be attributed to a fact mentioned by the director of the technical department: that most staff members were not willing to share their know-how in the learning process. Chang (2005) argued that the effectiveness of organisational learning is not equal to the sum of the effectiveness of individual learning, and may be either higher or lower than the sum of individual learning effectiveness. Effectiveness of organisational learning mainly depends on the degree of know-how sharing. Although the organisation pays attention to individual learning, the industry still lacks a culture devoted to knowledge sharing, making this factor unable to improve the effects of ITT.

Since the variable “I am willing to learn the know-how by team unit” had a t-value of -2.137

and a p-value of 0.033, it was excluded from the regression equation. Considering that this researcher has used a stepwise regression, this factor might be significant to the ITT effect. This finding is consistent with previous research by Johnson et al (2000), who state that team work can be successful when individuals in the team do what they feel is right and is not afraid of taking risks. In other words, ITT may be successful when members are willing to learn by team units. The effectiveness of team learning is not equal to the sum of members' learning effectiveness, and it may be higher or lower than this sum, depending on members' learning enthusiasm and degree of sharing of know-how. Members are willing to learn know-how in team units, but they are not willing to share their learned know-how, which means this factor is negatively correlated to ITT effects.

Excluded Variables[t]

Rows 701 through 800 of 858

Model	Beta In	t	Sig.	Partial Correlation
q45 members of my team have the capability to learn the know-how	.091[p]	1.076	.283	.056
q46 team and organization have common goals while absorbing the knowledge	.195[p]	2.349	.019	.121
q52 organization is willing to share knowledge with my team	-.016[p]	-.210	.833	-.011
q53 organization has strong desire to absorb know-how	-.027[p]	-.334	.738	-.017
q54 organization invested sufficiently R&D to promote the knowledge accumulation for absorbing know-how	.020[p]	.286	.775	.015
q56 organizational learning has been given enough attention	.021[p]	.247	.805	.013
q57 organization learns the successful licensing experience	.008[p]	.236	.814	.012
q58 organization shares the experience of technology transfer with other organizations	.032[p]	1.062	.289	.055
q59 organization gains the external support from other organizations	.056[p]	1.553	.121	.080
q60 top manager participates regularly in the activities of learning know-how	.031[p]	.867	.387	.045
q61 inter-organizational learning has been given enough attention	-.002[p]	-.066	.947	-.003

Table 7.11 Non-significant variables were excluded from the regression model.

Since the variable "my team and organisation have common goals" had a t-value of 2.349 and a p-value of 0.019, it was excluded from the regression equation. Considering that this researcher has used a stepwise regression, this factor may be significantly connected to ITT effects. This finding is consistent with previous research by Johnson et al (2000), who show that ITT may be successful if teams linked their goals with the organisation's goals.

Since the variable “organisation has strong desire to absorb know-how” had a t-value of -0.334 and a p-value of 0.738, it was excluded from the regression equation. It means that this factor is not significantly connected to the ITT effect. This result is consistent with the findings from interview analyses, in which the captain of the miner team stated that the coal mine did have a strong desire to absorb know-how in order to promote its technology levels, but that the learning enthusiasm of team members has not been motivated by the organisation. In addition, the captain also mentioned that each member only passively followed an organisational desire to learn, which is not likely to improve learning effects.

Since the variable “organisation invested sufficiently in R&D to promote knowledge accumulation” had a t-value of 0.286 and a p-value of 0.775, it was excluded from the regression equation. This means that this factor is not significantly connected to ITT effects. This finding is inconsistent with previous research by Madu (1989) and Lai and Tsai (2009), which found that the amount of funding invested in R&D influenced the effectiveness of ITT. This inconsistency might be attributed to a fact mentioned by the director of the technical department: that the coal mine had invested sufficiently in R&D since 2010 to promote knowledge accumulation. However, knowledge accumulation is a long process; true technological progress requires the coal mine to wait longer.

Since the variable “the organisational learning has been given enough attention in organisation during the process of licensing” had a t-value of 0.247 and a p-value of 0.805, it was excluded from the regression equation. This means that this factor is not significantly connected to ITT effects. This researcher is surprised to find this result, which does not coincide with the previous research by Sun and Scott (2005). Their research indicated that organisational learning was a main factor affecting knowledge transfers. The inconsistency could be attributed to a fact mentioned by the director of the technical department: that the effectiveness of organisational learning depends on the degree of know-how sharing, but that most organisation members are not willing to share their know-how in the learning process. Although organisational learning has been given enough attention within the organisation, it is not likely to influence ITT effects.

Since the variables “organisation learns the successful licensing experience from other organisations”, “organisation shares the experience with other organisations” and “organisation gains the external support from other organisations” had t-values of 0.236, 1.062 and 1.553 and p-values of 0.814, 0.289 and 0.121, they were excluded from the regression equation. This means that the three factors are not significantly connected to ITT effects. This finding is inconsistent with previous research by Jian et al (2010), who states that an organisation which learns successfully from the experiences of other organisation, which shares experience with them, and which gains their trust and support would have a positive influence over the effectiveness of their ITT. This inconsistency can be attributed to a fact mentioned by the director of the technical department: that there is great competitive pressure between coal mines. Although all coal mines are state-owned, the top leader of each coal mine still hopes to present better performances than their competitors in order to obtain promotional opportunities, such as the chance that they might be promoted to the state administration of coal mine safety or provincial governments. This situation causes a number of coal mines to be unwilling to share their know-how and successful experience with their competitors; most coal mines only share common knowledge and experience with their competitors, because enterprise leaders do not want their competitors to present better performances than themselves. Even though organisations learn successful ITT experience and gain external support from other organisations, this experience and support is only a transfer of common knowledge and symbolic help rather than sharing know-how and valuable experience. For the same reason, organisations are not willing to share know-how and valuable experience with other organisations. This situation means these three factors are unable to improve ITT effects.

Since the variable “top managers participate regularly in the activities of learning” had a t-value of 0.867 and a p-value of 0.387, it was excluded from the regression equation. This means that this factor is not significantly connected to ITT effects. This result is consistent with the findings from interview analyses, in which the captain of the miner team pointed out that top manager should not participate in learning activities, and less interference from managers encourages staff to show higher subjective initiative. In particular, a number of managers do not understand the relevant knowledge yet still participate in learning activities.

Since the variable “the inter-organisational learning has been given enough attention in organisation” had a t-value of -0.066 and a p-value of 0.947, it was excluded from the regression equation. It means that this factor is not significantly connected to ITT effects. The finding is inconsistent with previous studies by Sun and Scott (2005), who found that inter-organisational learning affects knowledge transfers. This inconsistency can be attributed to a fact mentioned by the director of the technical department: a number of coal mines are not willing to share know-how and successful experience with other coal mines in the process of inter-organisational learning, since the top leaders of each coal mine hope to present better performances than other coal mines in order to obtain promotion opportunities. Although inter-organisational learning has been given plenty of attention within the organisation, in practice this factor is unable to influence ITT effects.

7.4 Hypotheses Tests

This section will test the research hypotheses in order to determine whether they should be supported or rejected. Table 7.15 describes the results of hypotheses testing; stepwise regressions were used to test whether each of the six research hypotheses was valid. The researcher combined variables of each construct into a single score by taking their average. For example, question 11 (variable 11) to question 20 (variable 20) have been combined into a single variable to represent the government's perspective, as shown in Table 7.12. Before that, a scale reliability analysis was conducted to determine if they all fit within the same construct. Table 7.13 depicts the result of scale reliability analysis, which shows that all alpha coefficients exceed 0.80, which indicates good scale reliability.

	Combined Variables	New Variable
1	Variable 11, 12, 13, 14, 15, 16, 17, 18, 19, 20	Government
2	Variable 21, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33	Organisational Technology Management
3	Variable 34, 35, 36, 37, 38, 39, 40, 41	Individual Learning
4	Variable 42, 43, 44, 45, 46, 47, 48, 49	Team Learning
5	Variable 50, 51, 52, 53, 54, 55, 56	Organisational Learning
6	Variable 57, 58, 59, 60, 61	Inter-organisational Learning

Table 7.12 combination of variables into a single score to represent each construct

	Cronbach's Alpha	F	Sig

New Variable 1	0.876	45.534	0.000
New Variable 2	0.942	325.001	0.000
New Variable 3	0.907	3.756	0.000
New Variable 4	0.955	13.115	0.000
New Variable 5	0.957	4.746	0.000
New Variable 6	0.804	1.967	0.097

Table 7.13 the results of scale reliability analysis

The following is a multiple regression equation:

$$Y\ (\text{ITT Effect}) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \varepsilon$$

Notes: β_0 = constant; β_n = regression coefficient for the predictor; dependent variable = ITT effect; independent variables = various dimensions; ε = error constant arising from the prediction values and the actual observed values, which are subjected to variability and cannot be expressed as exactly a linear relationship.

Dependent Variable	
Y	ITT effect
Independent Variables	
X_1	Government
X_2	Organisational Technology Management
X_3	Individual Learning
X_4	Team Learning

X_5	Organisational Learning
X_6	Inter-organisational Learning

Table 7.14 Combined Dependent variable and independent variables

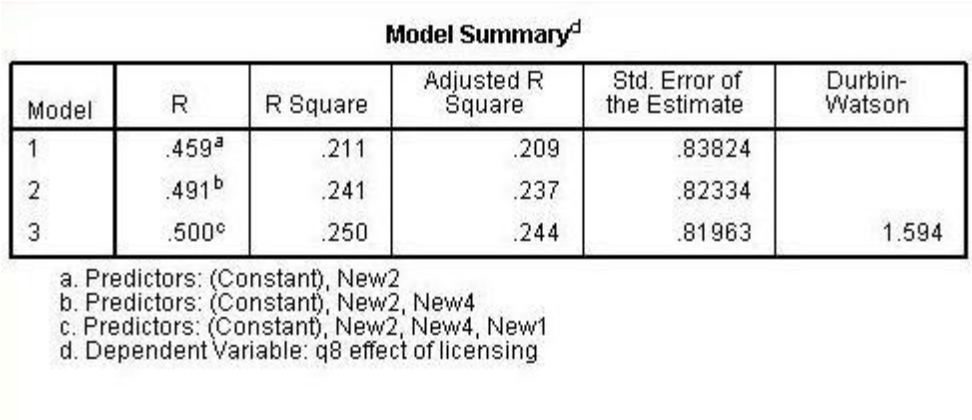
The analysis was run on the IBM SPSS 20. Table 7.15 presents the results of analysis, which show a significant adjust R square of 0.244 for the correlation between ITT effect and X_2 (organisational technology management), $X_{4(\text{team learning})}$, $X_{1(\text{government})}$. Therefore, these three constructs are considered to be significant to the ITT effect.

The following is a multiple regression equation after performing a stepwise regression:

$$Y\text{ (ITT Effect)} = \beta_0 + \beta_2 X_2 + \beta_4 X_4 + \beta_1 X_1 + \varepsilon$$

The following is a multiple linear regression equation with coefficients:

$$Y\text{ (ITT Effect)} = 1.824 + 0.946X_2 - 0.237X_4 - 0.271X_1 + \varepsilon$$



Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.459[a]	.211	.209	.83824	
2	.491[b]	.241	.237	.82334	
3	.500[c]	.250	.244	.81963	1.594

a. Predictors: (Constant), New2
b. Predictors: (Constant), New2, New4
c. Predictors: (Constant), New2, New4, New1
d. Dependent Variable: q8 effect of licensing

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	1.696	.142		11.912	.000		
	New2	.515	.051	.459	10.133	.000	1.000	1.000
2	(Constant)	1.582	.143		11.070	.000		
	New2	.812	.092	.725	8.874	.000	.297	3.364
	New4	-.283	.073	-.317	-3.876	.000	.297	3.364
3	(Constant)	1.824	.183		9.992	.000		
	New2	.946	.111	.844	8.532	.000	.201	4.979
	New4	-.237	.076	-.265	-3.117	.002	.272	3.670
	New1	-.271	.128	-.190	-2.115	.035	.244	4.099

a. Dependent Variable: q8 effect of licensing

Excluded Variables[d]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance	Collinearity Statistics VIF	Collinearity Statistics Minimum Tolerance
1	New1	-.271[a]	-3.114	.002	-.157	.266	3.758	.266
	New3	-.356[a]	-3.686	.000	-.185	.213	4.692	.213
	New4	-.317[a]	-3.876	.000	-.194	.297	3.364	.297
	New5	-.215[a]	-2.802	.005	-.142	.344	2.908	.344
	New6	-.149[a]	-2.044	.042	-.104	.381	2.625	.381
2	New1	-.190[b]	-2.115	.035	-.108	.244	4.099	.201
	New3	-.182[b]	-1.318	.188	-.067	.104	9.612	.104
	New5	.103[b]	.744	.458	.038	.104	9.607	.090
	New6	.004[b]	.049	.961	.003	.268	3.736	.209
3	New3	-.156[c]	-1.130	.259	-.058	.103	9.697	.103
	New5	.125[c]	.906	.366	.046	.104	9.659	.089
	New6	.003[c]	.033	.974	.002	.268	3.736	.190

a. Predictors in the Model: (Constant), New2
b. Predictors in the Model: (Constant), New2, New4
c. Predictors in the Model: (Constant), New2, New4, New1
d. Dependent Variable: q8 effect of licensing

Table 7.15 results of hypotheses testing and stepwise regressions

Government has a positive correlation with effectiveness of ITT (H1)

Analysis results presented in Table 7.15 reveal a significant negative correlation between ITT effects and government, with a t-value of -2.115 and a p-value of 0.035. H1 was therefore rejected. This finding is consistent with previous research by Li (2011), who was the Director General of State-owned Assets Supervision and Administration Commission of the China State Council from 2003 to 2010; he pointed out that the Chinese government intervened excessively in the business operations of state-owned enterprises, and the government's managerial behavior seriously affected these enterprises' development and resulted in poor business performances. This analysis result is also consistent with the findings from interview analyses, in which the deputy general manager stated that a number of provincial governments had not investigated the true situation of their coal mines before making relevant policies. These local governments have also ignored the advice and feedback from coal mines. This all resulted in new policies which were easily made but implemented with difficulty. In addition, a number of policies limit coal mines by setting requirements to learn know-how for innovation. The original intention of the government was to encourage and enable coal mines to learn know-how for innovation through ITT, but it is very difficult for the mines to achieve the government's expected results (Sun, 2011). Because these unrealistic policies seriously impeded coal mines from absorbing transferred knowledge based on their advantages, this intervention also leads to the poor ITT effect.

Technology management has a positive correlation with effectiveness of ITT (H2)

Table 7.15 revealed a significant positive correlation between ITT effects and organisational technology management, with a t-value equal to 8.532 and a p-value equal to 0.000. H2 was therefore supported. This finding is consistent with previous research by Megantz (2002), who states that technology management is a vital dimension influencing ITT effects. The result is consistent with the findings from interview analyses, in which the general manager of the large state-owned coal mine opined that organisational technology management played an important role in the process of ITT. In addition, the results of a stepwise regression revealed that organisational technology management was a main indicator which contributed 20.9 percent of the variance to ITT effect.

Individual Learning has a positive correlation with effectiveness of ITT (H3)

Table 7.15 revealed a negative but non-significant correlation between ITT effects and individual learning, with a t-value equal to -1.130 and a p-value equal to 0.259. H3 was therefore rejected. This finding is inconsistent with previous studies by Sun and Scott (2005), who state that individual learning is positively and significantly correlated with knowledge transfers. This inconsistency might be attributed to a fact mentioned by the captain of the miner team: that the coal mine asked staff to learn know-how under specific objectives, which were based on the enterprise's profit rather than staff interest. This led to a situation in which the learning effectiveness of staff is very low and learning enthusiasm was been motivated. Cao (2005) considered that improving learning effects was necessary to motivate staff learning enthusiasm; rather than limiting them under specific objectives, enterprises should change their management strategy from "want staff to learn" to "staff want to learn".

Team learning has a positive correlation with effectiveness of ITT (H4)

Table 7.15 revealed a significant negative correlation between ITT effects and team learning, with a t-value equal to -3.117 and a p-value equal to 0.002. H4 was therefore rejected. This finding is inconsistent with previous research by Sun and Scott (2005), who state that team learning is positively and significantly correlated with knowledge transfers. This inconsistency might be attributed to a fact mentioned by the director of the technical department: that there is huge competitive pressure among staff, with each staff member worried about others acquiring more know-how in the process of team learning. Hall (2001, p. 19) argues that ''knowledge creates knowledge only when it is shared'', but it is difficult to achieve good ITT effects when staff is not willing to share know-how in the process of team learning. Hendriks (1999) argued that effective team learning needs to share know-how among members; only through interpersonal know-how becoming collective knowledge can team learning achieve good effects.

Organisational learning has a positive correlation with effectiveness of ITT (H5)

Table 7.15 revealed a positive but non-significant correlation between ITT effects and organisational learning, with a t-value equal to 0.906 and a p-value equal to 0.366. H5 was therefore rejected. This finding is inconsistent with previous studies by Sun and Scott (2005), who state that there is a positive and significant correlation between knowledge transfer and organisational learning. This inconsistency can be attributed to a fact mentioned by the director of the technical department: that most staff are not willing to share know-how in the learning process. Chang (2005) argues that the effectiveness of organisational learning mainly depends on the degree of know-how sharing, but the Chinese coal mining industry lacks a culture of knowledge sharing.

Inter-organisational learning has a positive correlation with effectiveness of ITT (H6)

Table 7.15 revealed a positive but non-significant correlation between ITT effects and inter-organisational learning, with a t-value equal to 0.033 and a p-value equal to 0.974. H6 was therefore rejected. This finding is inconsistent with previous research by Sun and Scott (2005), who state that there is a positive and significant correlation between knowledge transfers and inter-organisational learning. This inconsistency could be attributed to a fact mentioned by the director of the technical department: that each coal mine hoped to learn know-how in the process of ITT, but that the top leaders of each coal mines are not willing to share learned know-how with other coal mines in the process of inter-organisational learning. Aswathappa (2005) found that an enterprise's competitive advantage often stems from its management and know-how. The top leaders of each coal mine worry that other coal mines will learn their know-how in the process of sharing knowledge and present better performances than themselves. Although sharing know-how could be a win-win result, the top managers are not willing to risk it.

7.5 Summary

This section offers a model regarding the relationship between ITT effects and influential factors based on this chapter's previous discussion. The results of the regression analysis reveal that six factors are positively and significantly connected to ITT effects, six factors might be positively and significantly connected to ITT effects, eight factors are negatively and significantly connected to ITT effects, two factor might be negatively and significantly connected to ITT effects, and 32 factors might not be significantly connected to ITT effects. In addition, six hypotheses have been tested: one hypothesis has been accepted and five others have been rejected.

Based on the results of data analysis from Table 7.8, the summaries of significant positive factors connected to ITT effects are presented in Table 7.16.

	B	t	Sig.
Q. 15 Making safeguard regulations	0.103	2.913	0.004
Q. 17 Punishing IPR violation	0.126	3.303	0.001
Q. 24 Building learning atmosphere	0.186	4.242	0.000
Q. 30 Providing relevant training	0.173	3.551	0.000
Q. 49 Good team learning	0.208	2.897	0.004
Q. 51 Having knowledge background	0.350	5.138	0.000

Table 7.16 summaries of significant positive factors connected to ITT effects

These results correspond with the interview findings and previous research by Kirkland (1999), Liao et al (2006), Madu (1989), Sun and Scott (2005), and Zhang (2009); for a detailed discussion see section 7.3.

Based on the results of the data analysis from Table 7.8, a summary of the significant negative factors connected to ITT effects are presented in Table 7.17.

	B	t	Sig.
Q. 5 Output of coal mine	-0.325	-9.564	0.000
Q. 11 Innovation strategy	-0.205	-7.221	0.000
Q. 18 Encouraging agency development	-0.122	-4.431	0.000
Q. 38 Common goals	-0.067	-3.105	0.002
Q. 47 Do not need to be afraid of displaying ignorance	-0.235	-6.349	0.000
Q. 48 Team managers participate in learning	-0.180	-5.189	0.000
Q. 50 Good vision	-0.354	-12.817	0.000
Q. 55 Middle managers participate in learning	-0.198	-4.624	0.000

Table 7.17 summary of the significant negative factors

These results correspond with interview's finding and previous research by Lai and Tsai (2009), Lihua (2002), He and Si (2010), and discussion about this was elaborated in section 7.3.The following is a multiple linear regression equation with coefficients, and it revealed a significant adjusted R square of 0.773 for the overall correlation between ITT effects and 14 influential factors, including creating safeguard regulations, punishing IPR violation, building a learning atmosphere, providing relevant training, good team learning, having background knowledge, output of coal mine, innovation strategy, encouraging agency development, common goals, displaying ignorance, team managers participate in learning, good vision, and middle managers participate in learning.

$$Y\ (\text{ITT Effect}) = 4.215 - 0.325X_{(\text{output of coal mine})} - 0.205X_{(\text{innovation strategy})} + 0.103X_{(\text{creating safeguard regulations})} - 0.122X_{(\text{encouraging agency development})} + 0.126X_{(\text{punishing IPR violation})} + 0.186X_{(\text{building a learning atmosphere})} + 0.173X_{(\text{providing relevant training})} - 0.067X_{(\text{common goals})} - 0.235X_{(\text{displaying ignorance})} - 0.180X_{(\text{team managers participating in learning}),} + 0.208X_{(\text{good team learning})} - 0.354X_{(\text{good vision})} + 0.350X_{(\text{having background knowledge})} - 0.198X_{(\text{middle managers participating in learning})} + \varepsilon$$

The empirical investigation results completely answered the main research question, which considered the main factors influencing the effectiveness of ITT in the Chinese coal mining industry. The overall quality of the equation is satisfactory, and a significant adjusted R square of 0.773 shows that a substantial proportion of ITT effects variance was explained by the equation. The dependent and independent variables have been objectively measured in this study, so the regression analysis produced objective findings.

Moreover, there are multicollinearity problems among the independent variables, and the questionnaire analysis used a stepwise regression. This means that a number of significant predictors might have been excluded from regression equation in order to improve the explanatory power of the equation. Therefore, based on the results of the data analysis from Table 7.9, Table 7.10 and Table 7.11, the researcher summarises the following factors which might be significant to ITT effect in Table 7.18

	B	t	Sig.
Q.16 Making systematic regulations to protect the IPR	0.097	1.974	0.049
Q.19 Building appropriate educational system	0.082	1.878	0.061
Q.20 Providing financial support	0.050	1.780	0.076
Q.42 Staff is willing to learn the know-how by team unit	-0.093	-2.137	0.033
Q.46 Team and organisation have common goals	0.195	2.349	0.019

Q.31 Arranging professional staff select technology	0.066	1.615	0.107
Q.33 Technology management played a positive role	0.055	1.435	0.152
Q.12 Encouraging the learning of know-how for innovation	-0.059	-1.690	0.092

Table 7.18 factors which may be significantly connected to ITT effects

These analysis results correspond with the interview findings and previous research by Kirkland (1999), Madu (1989), Lai and Tsai (2009), Jasinski (2009), and Johnson et al (2000), and a detailed discussion was presented in section 7.3.

Based on the results of the data analysis from Tables 7.9, Table 7.10 and Table 7.11, a summary of the non-significant factors connected to ITT effects are presented in Table 7.19.

	B	t	Sig.
Q.6 Location of coal mine	0.033	1.342	0.180
Q.9 Fulfilling contractual obligations	0.039	1.561	0.119
Q.10 Good cooperation with transferees	0.006	0.241	0.810
Q.13 Encouraging the university and state research institutes to assist organisation	0.031	0.765	0.445
Q.14 Encouraging sufficient investment in R&D	-0.038	-1.486	0.138
Q.21 Having a special department responsible for licensing	-0.004	-0.173	0.863
Q.23 Creating innovation strategy	0.034	1.131	0.259
Q.25 Arranging professional staff to be responsible for IPR protection	0.016	0.516	0.606
Q.26 Arranging appropriate talented individual to manage the process of licensing	0.039	1.198	0.232

Q.27 Arranging sufficient financial resources to support licensing	0.047	0.857	0.392
Q.28 Building good knowledge communication system	0.047	1.387	0.166
Q.29 Building good discussion forums for learning	-0.019	-0.418	0.676
Q.32 Inviting external professionals or agencies select technology	-0.043	-1.027	0.305
Q.34 Building good rewarding system	0.035	0.889	0.375
Q.35 Managing staff under specific objectives	0.010	0.312	0.755
Q.36 Staff are willing to learn	-0.025	-0.735	0.463
Q.37 Staff are willing to share the learning experience with my team	-0.015	-0.406	0.685
Q.39 Staff have the clear learning motivation	0.045	0.965	0.335
Q.40 Staff have the capability to learn	-0.021	-0.637	0.525
Q.41 Organisation pays attention to individual learning	0.014	0.279	0.780
Q.43 The team members regularly share the learning progress	0.027	0.648	0.518
Q.44 The team leader rewarded staff when they obtained some learning progress	0.071	0.916	0.360
Q.45 The members of team have the capability to learn	0.091	1.076	0.283
Q.52Th organisation is willing to share knowledge with team	-0.016	-0.210	0.833
Q.53The organisation has strong desire to absorb know-how	-0.027	-0.334	0.738
Q.54 Sufficient investing R&D promote the knowledge accumulation	0.020	0.286	0.775

Q.56 The organisational learning has been given enough attention	0.021	0.247	0.805
Q.57 Learning the successful licensing experience from other organisations	0.008	0.236	0.814
Q.58 Sharing the experience with other organisations	0.032	1.062	0.289
Q.59 Gaining the external support from other organisations	0.056	1.553	0.121
Q.60 Top manager participates regularly in the activities of learning	0.031	0.867	0.387
Q.61 The inter-organisational learning has been given enough attention	-0.002	-0.066	0.947

Table 7.19 summaries of the non-significant factors connected to ITT effects

These analysis results correspond with interview findings and previous research by Pink (2009), He and Si (2010), and Cao (2005). On the other hand, they are inconsistent with interview findings and previous research by Samli (1985), Al-Thawwad (2008), Lai and Tsai (2009), Odigie (2012), Debackere and Veugelers (2005), Macho-Stadler et al (2007), Kirkland (1999), Madu (1989), Jasinski (2009), Campbell (2007) and Ganguli et al (2009), Bigge and Hunt (1980), Hall (2001), Sun and Scott (2005), and Jian et al (2010). For a detailed discussion of this, see section 7.3.

The following is a multiple linear regression equation with coefficients (see Table 7.20); it reveals a significant adjusted R square of 0.244 for an overall correlation between ITT effects and three main dimensions, which are presented in Figure 7.3.

$Y \text{ (ITT Effect)} = 1.824 + 0.946\ X_{2\ (\text{organisational technology management})} - 0.237\ X_{4(\text{team learning})} - 0.271$

$X_{1(government)} + \varepsilon$

	B	t	Sig.
H1. Government is positively correlated with effect of ITT	-0.271	-2.115	0.035
H2. Organisational technology management is positively correlated with effect of ITT	0.946	8.532	0.000
H3. Individual learning is positively correlated with effect of ITT	-0.156	-1.130	0.259
H4. Team learning is positively correlated with effect of ITT	-0.237	-3.117	0.002
H5. Organisational learning is positively correlated with effect of ITT	0.125	0.906	0.366
H6. Inter-organisational learning is positively correlated with effect of ITT	0.003	0.033	0.974

Table 7.20 Results of hypotheses testing

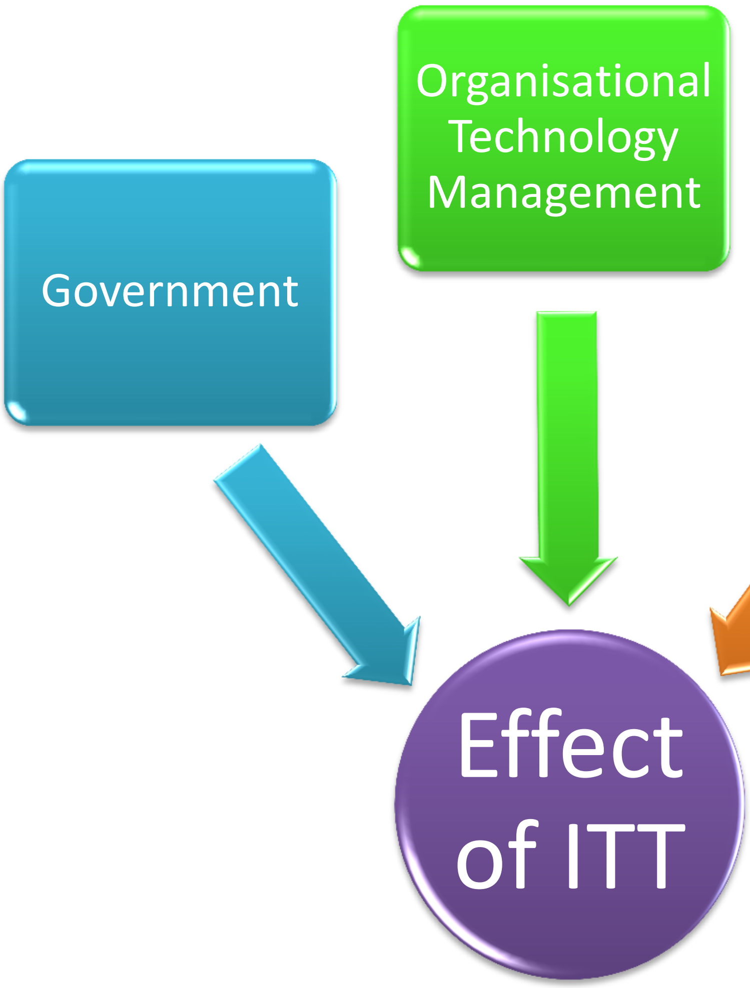


Figure 7.3 Results of hypotheses testing: three dimensions influencing the effectiveness of ITT

The results of the stepwise regression revealed that organisational technology management, as a main dimension, contributed 20.9 percent of the variance to the effect of ITT. This finding is consistent with previous research by Megantz (2002), who considered technology management to be a vital dimension influencing ITT effects. In addition, the government and team learning both negatively influenced the effectiveness of ITT. The finding is consistent with previous research by Li (2011), who points out that Chinese government excessively intervened in the business operation of state-owned enterprises, which seriously affected the enterprises' development and resulted in poor business performance. The finding is inconsistent with previous studies by Sun and Scott (2005), who found that team learning was positively and significantly correlated with knowledge transfers in the manufacturing industry and consultancy organisations in New Zealand. This inconsistent result was discussed in section 7.4.

In the next chapter, conclusions will be drawn based on the result of data analyses and discussions of observations, semi-structure interviews and questionnaires. The researcher will reveal findings, limitations of the study, and recommendations for managerial researchers, policy makers and coal mine managers.

Chapter Eight – Discussion and Conclusions

8.1 Introduction

This study investigated factors influencing the effectiveness of ITT in the Chinese coal mining industry. The motivation, aims and objectives of this study are presented in Chapter one. A wide range of literature is reviewed critically in Chapter two and three, which identified gaps in the literature and refined the definition of TT as a systematic knowledge transfer. Chapter four discusses ways to fully achieve this study's research objectives by creating the most appropriate research design and selecting suitable research methods: a combined case studies and survey as the research strategy has been implemented in this study. Chapter five presents the pilot case studies which gave this study a trial run. The findings of the main case studies are presented in Chapter six. Chapter seven tests the hypotheses and reveals causal relationships between affecting factors and ITT effects.

Based on the above, the conclusion of the current study is presented in this chapter, which starts by re-examining the aims and objectives of this study, then highlights the achievements of these aims and objectives, synthesises key findings of this study and presents the study's contribution to knowledge. Lastly, the chapter considers the implication and limitation of this study: recommendations for future research in this area are given, and the conclusion of the research is presented.

8.2 Reflections on Research Objectives

The aims and objectives of this study were presented in chapter one. This section will elaborate on the four objectives and the ways they have been achieved throughout the thesis.

Objective 1: To obtain an in-depth understanding of the concept and channels, as well as the necessity of ITT in the Chinese coal mining industry.

This objective has been achieved by a meticulous review of extant literature. The literature review revealed that TT are essentially systematic knowledge transfers. The foreign technologies usually transferred into the industry through licensing; it also revealed that ITT is necessary to the Chinese coal mining industry. Because ITT is a very important way to promote technology levels and solve gas problems, and provides a way to shrink technology gaps with developed countries, enjoy the latecomer advantage, and achieve technology leapfrogging.

Objective 2: To identify factors that influence the effect of ITT in the Chinese coal mining industry.

The case studies and survey were designed to achieve this objective. Based on a theoretical framework, six dimensions were assumed to influence the effectiveness of ITT. According to extant theories and empirical findings from the case studies, a number of factors were identified, and this researcher developed hypotheses on how these influence the effectiveness of ITT. The self-completed questionnaires were designed to further test these factors and determine whether they have causal relationships with the effectiveness of ITT. The findings of the survey are presented in Chapter 6.

Objective 3: To identify the implications of the relationships between the influential factors and ITT effects.

The researcher elaborated on the implications of the relationship of each factor through comparing the findings of the surveys with extant theories and the findings of the case studies. The detailed results of the analyses and discussions were presented in this chapter.

Objective 4: To develop a theoretical framework by critically examining the extant ITT theories.

The literature review, case studies and survey were designed to achieve this objective. This triangulated design revealed that a number of extant theories were not suitable for the Chinese coal mining industry, because these theories have been developed based on other contexts. The researcher understood the process of ITT and the current development situation of the Chinese coal mining industry after critical review of extant theories and empirical research, and developed a theoretical framework that was suitable for the Chinese context.

8.3 Synthesis of Overall Findings

8.3.1 Finding from Case Studies

The findings consist of the following six aspects:

Current situation of the Chinese coal mining industry

Scientific and technological progress have changed the development model of Chinese coal mining industry from a high-consumption, high-input and low-output production style to a low-carbon and environmentally friendly production style. The industry did not already rely on price competition by reducing costs and expanding production to occupy the market share, but relied on technological progress to promote competitive advantage.

Compared with the American coal mining industry, technology levels in the Chinese coal mining industry are still low and the many advanced technologies available still rely on foreign enterprise. This can be attributed to the fact that the long-term planned economy made the Chinese coal mining industry over-reliant on resources, and turns coal mining into a labor-intensive industry.

Currently, 70% of large state-owned coal mine technologies are from domestic suppliers, and 30% of technologies are from foreign suppliers such as Germany and Australia. 10% of local state-owned coal mine technologies are from foreign suppliers, and 5% of small coal mine technologies are from foreign suppliers. Coal mining of large and local state-owned mine has already achieved mechanisation, but most small coal mines still depend on manual mining.

In China, large state-owned coal mines occupy the best coal resources. In contrast, small coal mines can only occupy the leftover bits and pieces of coal resources, which are essentially shallow coal seams not willingly used by large state-owned coal mines. The reason for that shallow coal seams are still mined in China but not in the US or Australia is that it contributes to China's rapid economic growth, which requires a large amount of coal in order to ensure the generation of electricity and steel-making.

Currently, the Chinese government is implementing a series of mandatory policies for promoting the technology levels of small coal mines: this includes the requirement that state-owned coal mines must merge with small private coal mines in order to form new coal enterprises run by the managers of state-owned coal enterprise. However, the effect of these mergers is not good. This can be attributed to the fact that managers of state-owned coal mines are unwilling to merge with small coal mines, since their mining conditions are extremely complex and the risk of mining is very high. In other words, small coal mines are like a time bomb for managers of state-owned coal mines. If the small coal mine has an accident after the merger, the managers of state-owned mine will be held responsible and sacked.

Understanding of ITT in the Chinese coal mining industry

The Chinese coal mining industry is changing its conception of ITT from the purchasing of technology to the learning of knowledge. Large state-owned coal mines were aware that ITT is not purely spending money to buy technology, but to learn and absorb transferred knowledge. Both the local state-owned coal mine and the small coal mine had a similar understanding of ITT, in which they considered ITT as a technology trade wherein the transferee purchases the technology from a transferor; hence, the technology level of the recipient would be improved with greater funding, since money can buy more advanced technologies from foreign enterprises.

Interviewees at the large state-owned coal mine agreed that sufficient funding is able to enable and improve the effects of ITT, but it is not the crucial factor needed to achieve effective ITT. If technology can be only being gained through purchase, the large state-owned coal mine should have the most advanced technology in the world. In fact, a number of state-owned and small coal mines purchased only technology without gaining know-how. This triggers a vicious circle that China's coal mining industry has become trapped in: "transfer — get behind — transfer again — get behind again".

If managers of the state-owned and small coal mines are not able to change their understanding of ITT, they will not achieve successful ITT even if they own sufficient funding.

Necessity of ITT in the Chinese coal mining industry

The main challenge faced by the Chinese coal mining industry is the problem of safety, which is concentrated in gas accidents which occurred almost every day in China. 2,433 miners died in the Chinese coal mines in 2010 (State Administration of Work Safety, 2011), on average more than 6 miners lose their lives due to accidents every day, and this accounted for about 70% of the world's coal mining casualties.

Strengthening safety management and transferring advanced technology may be the two most effective ways to solve the safety problem. Safety management is not a problem for large state-owned coal mines, but it is still a main challenge faced by local state-owned coal mines and small coal mines, because the managers of these coal mines often violated safety regulations and give unsafe commands to miners. Large state-owned coal mines solve their gas problems by relying on the transfer of advanced foreign technology; local state-owned coal mines and small coal mines solve their gas problems by strengthening their safety management and transferring advanced technology.

Currently, the mining depth of the large state-owned mine has already reached past 1,500m underground; massive amounts of gas are released into the tunnel when deeper coal seams are mined, and the complicated geographical structure of deeper coal seams means that the ventilation system is only able to drain some of the gas. This researcher noticed a strong smell of gas when visiting the underground tunnel of the large state-owned coal mine, because the drilling depth of the current domestic CBM drainage technology only reaches 700m and is unable to drain methane effectively from deeper coal seams before mining. However, Australia CBM drainage technology can drill to 1,500m underground and drain gas effectively from deeper coal seams before mining.

In addition, the State Council published "Opinions in Accelerating Drainage and Utilization of Coal Seam Methane" on 15th June 2006; according to the fifth Article, coal seams can only be mined by miners when the gas concentration of the coal seam has been drained below the standard required level. The Article has forced large state-owned coal mines to adopt advanced foreign technology to drain methane before mining.

Current situation of ITT in the Chinese coal mining industry

ITT in the Chinese coal mining industry is experiencing a transformative period, moving from the acquisition of technology to solve the specific problem to the learning and assimilating of transferred knowledge for innovation. The main reason of the large state-owned coal mine engages in ITT is the national mandatory policy which requires them to solve their gas problems before mining in order to guarantee operational safety. Foreign technologies and equipment are more reliable and efficient at solving gas problems, but they are more expensive than domestic ones. The large state-owned coal mines do not need to worry about funding: since the average coal price has continued to increase from 246 RMB/ton (Xinhua, 2005) to 618 RMB/ton (Sina, 2013), they have abundant capital to acquire foreign advanced technology. The local state-owned and the small coal mines, however, face challenges of funding and technology capability. Since their sizes are not large and their production is not high, their insufficient funding does not allow them to engage in ITT. Moreover, technology levels in local state-owned and small coal mines are relatively low: even if the mines had sufficient funding, they would not have sufficient technology capability to digest and absorb the transferred technology due to the existing technology gap between them and the transferor. Furthermore, a lack of professional technicians also makes it difficult to engage in ITT.

Ways in which foreign technology is transferred to the Chinese coal mining industry

Foreign technology has always been transferred to the large state-owned coal mine through licensing rather than foreign direct investment and joint venture, because coal in China is a national strategic resource that occupies a pivotal position and 72 percent of China's energy consumption is from coal (according to China Coal Industry Association, 2012). The Chinese government has established and enforced a series of policies and regulations to protect large state-owned coal mines and gain substantial coal resources, and these policies and regulations essentially limit foreign enterprises from investing in and controlling coal sources in China. On the other hand, the Chinese government does not encourage FDI in the Chinese coal mining industry: if foreign enterprises wish to set up joint venture with Chinese coal enterprises, the joint venture can only be set up under a condition that the Chinese party holds a majority share. These policies lead to a situation in which large state-owned coal mines must adopt licensing to obtain foreign technology.

Factors influencing the effectiveness of ITT

Large state-owned coal mines started to use transferred foreign technologies to solve gas problems in 2003, but the effectiveness of the transferred technologies was below their expectations. The extant literature and findings from the case studies revealed factors influencing the effectiveness of ITT can be categorised in six dimensions: the government, organisational technology management, and four levels of learning within an organisation, which consist of individual, team, organisational and inter-organisational learning.

First, all policies in the coal mining industry are set by the government. These policies directly influence the effectiveness of ITT. In order to achieve a successful ITT, the government needs to make relevant policies and provide financial support to encourage coal mines to innovate, invest in R&D and cooperate with universities and state research institutes.

The government also needs to draw up a strategy for technological innovation and encourage the development of professional TT agencies. Currently, the coal mining industry lacks professionals to digest and absorb transferred technologies; the government should improve the current education system in order to nurture sufficient talented individuals.

Secondly, organisational technology management is a vital dimension influencing ITT effects, but the coal mining industry lacks professional individuals who specialise in technology management. In order to achieve successful ITT, coal mines should arrange for professional staffs and external agencies to select technologies before ITT is carried out. The mines also need to provide training for their staff and highlight the importance of IPR protection before ITT. Recipients should create a good learning environment and provide sufficient funding so that staff can digest and absorb transferred knowledge continuously and effectively.

Third, most members are not willing to share their know-how in the process of individual learning, because there is great competitive pressure among them. Members are worried that others are learning more know-how than them in the process of knowledge sharing.

Fourth, team learning focuses on finishing the learning tasks distributed by higher management level. The learning tasks are distributed passively, rather than selected by each team on their own initiative and focused on their interests and advantages. In addition, the managers of the coal mine over-participate or interfere in team learning: a number of managers do not have relevant knowledge of the tasks given, but they still interfere with learning activities. This leads to a situation in which team learning may negatively influence the ITT effect.

Fifth, organisational learning should sufficiently consider employees' learning interests, rather than focusing only on organisational profit. However, the current situation is that organisational learning only focuses on the enterprise's profit, and leaves employees' learning interests at a much lower priority. The learning may be satisfactory from the enterprise's standpoint, but it is not supported by the staff.

Finally, although most coal mines are state-owned, the top managers of the coal mines are not willing to share their know-how and experience with other state-owned coal mines, they hope to show better performance than other coal mines in order to obtain promotional opportunities.

8.3.2 Findings from Surveys

The results of the regression analysis revealed that six factors clearly have a positive and significant connection to ITT effects, six factors might have a positive and significant connection to ITT effects, eight factors clearly have a negative and significant connection to ITT effects, two factors might have a negative and significant connection to ITT effects, and 32 factors might be insignificant to ITT effects. Figure 8.1 presents the positive and negative correlations between ITT effects and these influential factors. In addition, six hypotheses have been tested: these test found that technology management is positively and significantly connected to effectiveness of ITT, and government and team learning are negatively and significantly connected to effectiveness of ITT.

Figure 8.1 Positive and negative correlations between ITT effect and affecting factors

8.3.3 Summary

This study was designed to answer the research question asking what factors influence the effectiveness of ITT in the Chinese coal mining industry, which has not yet been clearly answered by extant literature. Looking back at the implementation process of this study, it first established a theoretical framework based on existing theories and consisting of six dimensions; the dimensions consist of 54 factors identified from extant literature and findings of its case studies and are assumed to influence the effectiveness of ITT. The findings from the survey prove that three of the six dimensions and 14 of the 54 factors have significant relationships with ITT effects. This indicates that a large state-owned coal enterprise wishing to achieve a successful ITT needs to first solve the following main problems revealed through empirical findings. First, the government excessively intervened in business operations of coal enterprises, which seriously affected the enterprise's development and resulted in poor business performance. The government usually draws up policies or strategies based on its profit rather than the practical situation of coal mines. Second, the coal enterprise lacks a culture and atmosphere of willingness to share openly learning outcomes. Third, the top managers of the coal mine should not excessively participate or interfere in learning activities. Less interference on the part of managers will give more freedom and space to learners.

In addition, the results of a stepwise regression revealed that technology management is the most important dimension and indicator, which contributed 20.9 percent of the variance to the effectiveness of ITT. It should thus be given more attention in the process of ITT.

8.4 Contribution to knowledge

In conducting a thorough literature review, this researcher found that there is a substantial body of literature concerning ITT in other contexts, but virtually nothing has been written about ITT in the coal mining industry in China. The uniqueness of this study lies in contributing to extant theories by highlighting the importance of government, technology management and team learning, which are three main dimensions influencing the effectiveness of ITT. This study also tested the ability to apply existing general theories to the Chinese coal mining industry, and found that a number of extant theories are not applicable to the industry.

These findings have significant implications for academics in terms of widening the understanding of challenges and benefits of existing theories in the Chinese coal mining industry. It is also useful for decision-makers and managers of coal enterprises, as it can help them to understand and pay more attention to technology management and team learning in order to improve disadvantages and strengthen advantages for achieving successful ITT. It also assists government policymakers to understand that their current policies may result in weak ITT effects and should be further improved. This study opens the gates to new thoughts and studies in the field.

8.4.1 Theoretical Contributions

Most previous research in the field overemphasized the ability of geography, culture, economy, intellectual property rights and business to influence the effectiveness of ITT, and neglected government, technology management and team learning as the three controllable and vital dimensions influencing the effectiveness of ITT. The majority of research only focused on the process of technology acquisition and neglected the process of technology absorption. Research by Samli (1985), Madu (1989), Kirkland (1999), Jasinski (2005), Sun and Scott (2005), Lihua and Khalil (2006), and Lai and Tsai (2009) provided a valuable basis for this study, but the findings from this survey are inconsistent with their research, which means that their theories are not applicable to the Chinese coal mining industry.

The theoretical contribution of this study is the demonstration that the government, technology management and team learning are three controllable and vital dimensions influencing the effectiveness of ITT. This current research developed a theoretical framework to fill the theoretical gap in the field of ITT in the Chinese coal mining industry. Moreover, the current research revealed the relationships between 14 different factors and ITT effects:

these factors include creating safeguard regulations, punishing IPR violations, building a learning atmosphere, providing relevant training, good team learning, having background knowledge, output of coal mine, innovation strategy, encouraging agency development, common goals, displaying ignorance, team managers participating in learning, good vision, and middle managers participating in learning. The findings complement the deficiencies in existing theories of ITT research field.

8.4.2 Practical Contribution

Practically, this study contributed to extant literature concerning the ITT on licensing. There has been much discussion and debate in the business and management fields about the factors influencing the effectiveness of ITT. However, there has been a lack of empirical and practical research into the ways transferred technology has been acquired, assimilated and innovated in the process of ITT. Most of these used available data from indirect sources, for example: taking data mainly from publications rather than a direct inquiry. Nevertheless, the empirical findings of this study present a richer insight on how to absorb and innovate based on transferred technology. It is important for the management teams of coal enterprises to be aware of and evaluate the influences of the government, technology management and team learning on ITT effectiveness. Governors and managers should also understand the various affecting factors in order to control these factors and achieve a successful ITT. In addition, the regression model used is able to help managers predict ITT effects.

8.5 Implications

The implications derived from this research could help the Chinese coal mining industry to find ways to improve the effectiveness of ITT. The followings are proposed based on the findings of this study.

First, Chinese state-owned enterprises mainly serve the government. The government usually creates policies and strategies based on its profit without considering the enterprises' standpoint, and a number of provincial governments did not investigate the practical situation of each coal mine before making relevant policies. They have also ignored the advice and feedback from coal mines. This has led to a situation in which many policies were easily made but implemented with difficulty. In addition, a number of unsuitable or even impractical policies limit coal mines by forcing them to follow governmental requirements to learn know-how for innovation. Moreover, developing professional TT agencies is an effective way to facilitate ITT, but current policies focus only on the increasing number of agencies rather than promoting service quality, resulting in a situation where agency quantity is continually increasing but quality is not. Governors should be clearly aware of the ways current policies are negatively affecting ITT.

Second, the large state-owned coal mines lack effective management institutions in the process of assimilating transferred technologies. In order to encourage individuals and teams to absorb transferred technology, a number of managers participate in learning activities, although they do not understand relevant knowledge. They distribute learning tasks to each team and individual based on personal relationships, rather than having teams and individuals actively select appropriate tasks coinciding with their own interests and advantages. In other words, easy tasks might be distributed to those who have good personal relationships with the managers, while difficult tasks might be distributed to those who have weaker personal relationships with managers. Furthermore, the bonuses of individuals and teams will be deducted when learning tasks are not accomplished on time. This typical Chinese style of "guanxi" management accelerates the breeding of corruption and seriously influences learning effects. Top leaders need to be aware that the implementation of institutionalized management will be very necessary to the coal mining industry in the future.

Third, large state-owned coal mines lacked sufficient professionals to digest and absorb transferred technology. This may be attributed to the fact that the current education system has not provided sufficient talented individuals. In the Chinese coal mining industry, 14 out of 15 mining universities have changed their names and adjusted their research directions to service local economies and other industries; the exception is China University of Mining Technology, which has difficulty attracting graduates. This is because the coal mining industry gives students the impression of poor working environments and high risks. Students voted mining engineering to be “one of the most horrible ten disciplines in Chinese universities”. Both governors and senior managers need to be aware of these factors, which are leading to a talented individual shortage in the coal mining industry.

Finally, the senior managers of coal mines need to be aware that technology management plays a very important role in the planning, organisation, coordination and control throughout the process of ITT. Improving the effects of ITT requires managers to pay more attention to technology management.

8.6 Limitations

Although this researcher has taken several measures to ensure that the research strategy as rigorous and robust as possible, due to the narrow range of data collection and time constraints of the research, the current study still has limitations.

The first limitation is the general nature of the findings from the case studies, which should be considered because the quantity of the cases studied was only six: three of these were generated from the pilot study and three were conducted for the main study. Yin (2009, p.60) stated that both single- and multiple-case design can lead to successful case studies. The researchers should consider the multiple-case study when they have the resources. Therefore, it would be helpful to identify more accurately the factors influencing the effect of ITT and to develop more substantially the theoretical framework if the researcher was able to interview more interviewees from other coal mines. The inclusion of a multiple-case model may increase the chance of completing an accurate case study and may also provide a comparative view. Due to the practical reasons, which included the difficulty of gaining access to more coal mines, limited resources and time constraints of the research, this researcher chose to conduct a single-case study. Despite the fact that the findings of the case studies may be constrained by the data, which specifically reflects the unique contexts of the studied coal mines, it should be stated that the general nature of the findings in the case studies were reasonably consistent, and were largely confirmed by the quantitative findings from the questionnaire. Although the strategy of this study has limitations, the current study has offered additional perspectives to complement the existing research on ITT. It can assist other researchers to understand these cases in the future, especially for cases in similar conditions when licensing was adopted in large state-owned coal mines. It also enabled research into the ITT in the Chinese coal mining industry to be developed further and new ideas and issues to be taken forward.

8.7 Recommendations for Future Research

The research has generally answered the main research question, which investigated the main factors influencing the effectiveness of ITT, but it has given rise to the following research questions, which are recommended for future study.

- This study only conducted a single-case study; in order to improve the applicability of the findings, we suggest increasing the amount of the cases studied and extending the investigation into other aspects which may influence the effectiveness of ITT.
- The findings of this study revealed that the government, technology management and team learning are the three main dimensions influencing the effectiveness of ITT. Further research is needed to investigate each dimension individually in order to add more concrete information to the current findings.
- It is suggested that future studies should not only focus on investigating variables associated with the effects of ITT, but also on measuring variables associated with other aspects, for example the innovation of transferred technology and the promotion of technology levels.
- It is recommended that further studies explore comparative research between foreign and Chinese coal enterprises engaging in ITT, in order to add more in-depth information to the current findings.
- It is suggested that future studies should explore the significant role of both transferor and transferee in ITT.

8.8 Conclusion

This study presents an original investigation concerning factors influencing the effectiveness of ITT in the Chinese coal mining industry; it identified affecting factors and provided recommendations for improving ITT effects based on empirical study, and it also filled a number of gaps in the extant research. This study employed methodological triangulation by combining observation, interviews and questionnaires to ensure a robust research design. Meticulous design and implementation ensured authentic and reliable results in this study.

The overall results revealed that the government, technology management and team learning are the three main dimensions influencing the effectiveness of ITT. In addition, this study also identified creating safeguard regulations, punishing IPR violations, building a learning atmosphere, providing relevant training, good team learning, and having relevant background knowledge as the six main affecting factors which should be taken into consideration by managers of coal enterprises, because they are positively and significantly connected to ITT effects. The output of coal mines, innovation strategy, encouraging agency development, common goals, displaying ignorance, team managers participating in learning, good vision and middle managers participating in learning as the eight main influential factors which should be taken into consideration by managers of coal enterprises, because they are negatively and significantly connected to ITT effects.

References

Abott, C., Sexton, M., Jones, V. and Lu, S. (2007) 'Action learning as an enabler for successful technology transfer with construction SMEs', *RICS Research Paper Series*, Vol.7 (16).

Adam, Y., Ong, C. H. and Pearson, A. H. (1988) 'Licensing as an alternative to foreign direct investment: an empirical investigation', *Journal of Product Innovation Management*, Vol. 5, pp. 32-49.

Adeoba, A. (1990) 'Technology transfer and joint ventures: the Nigerian experience', in UNCTAD (Eds.), *Joint Ventures as a Channel for the Transfer of Technology*, United Nations, New York, pp. 107-120.

Al Ali, S. (1995) 'Developing countries and technology transfer', *International Technology Management*, Vol. 10, Nos. 7/8, pp. 704-713.

Albert, M. (2005) 'Managing change: creating a learning organization focused on quality', Problems and Perspectives in Management, 1, pp. 47-54.

Alkhafaji, A. (1986) 'Technology transfer: An overview as related to LDCs', *The Journal of Technology Transfer*, Vol 11, Issue 1, pp. 55-66.

Al- Thawwad, M. R. (2008) 'Technology transfer and sustainability- adapting factors: culture, physical environment, and geographical location', paper 152, *Proceeding Of the 2008 IAJC-IJME International Conference.*

Annual Coal Report, DOE/EIA-0584 (years 1993-2003) and DOE/EIA-0118 (years 1976-1992); Energy Information Administration: Washington, DC. In-house file data from U.S. Bureau of Mines, Annual Coal Production surveys by Bureau of Mines and by U.S. Geological Survey (years 1890-1975): Washington, DC. Available at: http://www.eia.gov/cneaf/coal/page/fig1_us_historical_production_bar_chart.xls (Accessed:

17 May 2009).

Argote, L. and Ingram, P. (2000) 'Knowledge transfer: a basis for competitive advantage in firms', *Organizational Behavior and Human Decision Processes*, 82(1), pp. 150-169.

Argyris, C. and Schon, D. A. (1996) *Organizational Learning II: Theory, Method and Practice*, Addison-Wesley, Reading.

Arrow, K. J. (1962) 'The economic implications of learning by doing', the Review of Economic Studies, Vol. 29, No. 3, pp. 155–73.

Aswathappa, K. (2005) *Human Resource and Personnel Management 4th Ed*, New Delhi: Tata Mc GRAW Hill Publication.

Atuahene- Gima, K. (1992) 'Inward technology licensing as an alternative to internal R& D in new product development: a conceptual framework', *Journal of Product Innovation Management*, pp.156-167.

Autio, E. and Laamanen, T. (1995) 'Measurement and evaluation of technology transfer: review of technology transfer mechanisms and indicators', *International Journal of Technology Management*, 10, (7/8), pp. 643-664.

Auty, R. M. (1994) *Economic Development and Industrial Policy: Korea, Brazil, Mexico, India and China*. Mansell Publishing Limited.

Awny, M. M. (2005) 'Technology transfer and implementation processes in developing countries', *International Journal of Technology Management*, 32, pp. 213-220.

Bachtler, J. (1991) 'Regionally-based technology transfer strategies report to working party No.6', *Organisation for Economic Cooperation and Development*, Paris.

Baert, P. (2005) *Philosophy of the Social Sciences: Towards Pragmatism*. Polity.

Baldwin, R. et al. (1999) *Multinationals, Endogenous Growth and Technological Spillovers: Theory and Evidence*. London, CEPR Dicussion Paper.

Barquin, R. (1981) 'Some introductory notes on transfer of technology', In: Godwin George (ed), '*Industrial Development and Technology Transfer'*.

Bawden, R. and Zuber-Skerritt, O. (2002) 'The concept of process management', *the Learning Organization*, Vol. 9 No. 3, pp. 132-9.

Bazeley, P. (2008) 'Mixed methods in management research', in R. Holt and R. Thorpe (eds.), *Dictionary of Qualitative Management Research*, Sage, London, pp.133-136.

Beeby, M. and Booth, C. (2000) 'Networks and inter-organizational learning: a critical review', *The Learning Organization*, Vol. 7 No. 2, pp. 75-88.

Bell, J. (1999) *Doing Your Research Project: A Guide for First-Time Researchers in Education and Social Science.* Buckingham; Philadelphia: Open University Press.

Bigge, M. L. and Hunt, M. P. (1980) *Psychological Foundations of Education: An Introduction to Human Motivation, Development, and Learning*. 3rd ed., Harper & Row, New York, NY.

Blackler, F. and McDonald, S. (2000) 'Power, mastery and organizational learning', *Journal of Management Studies*, Vol. 37, No. 6, pp. 833-51.

Bozeman, B. (2000) 'Technology transfer and public policy: a review of research and theory', *Journal of Research Policy*, 29 (4-5), pp. 627-655.

BP Statistical Review of World Energy, (2011) Available at: http://www.bp.com/assets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/statistical_review_of_world_energy_full_report_2011.pdf (Accessed: 17 May 2012).

BP Statistical Review of World Energy, (2012) Available at: http://www.bp.com/liveassets/bp_internet/china/bpchina_chinese/STAGING/local_assets/do wnloads_pdfs/Chinese_BP_StatsReview2012.pdf (Accessed: 11 March 2013).

Brannen, J. (1992) 'Combining qualitative and quantitative approaches: an overview', in J. Brannen, J. (1992) *Mixing Methods: Qualitative and Quantitative Research*, pp. 3–37. Aldershot: Avebury.

Brannen, J. (2008) 'The practice of a mixed methods research strategy: personal, professional and project considerations', in Manfred Max Bergman, (2008) *Advances in mixed methods research: theories and applications.* London: SAGE.

Branstetter, L., Fisman, R. and Foley, C. F. (2006) 'Do stronger intellectual property rights increase international technology transfer?' *Quarterly Journal of Economics*, 121(1), pp. 321-349

Brooks, H. (1966) 'National science policy and technology transfer', *Proceedings of Conference on Technology Transfer and Innovation*, Washington.

Bryman, A. (1993) *Quantity and Quality in Social Research*. Routledge, London.

Bryman, A. (2004) *Social Research Methods*. Oxford: Oxford University Press.

Bryman, A. (2006) 'Integrating quantitative and qualitative research: how is it done?' *Qualitative Research*, Vol. 6, No. 1, pp. 97-114.

Bryman, A. and Bell, E. (2007) *Business Research Methods*. Oxford University Press.

Bryman, A. and Bell, E. (2011) *Business Research Methods*. Oxford University Press.

Bryman, A. and Cramer, D. (2011) Quantitative Data Analysis with IBM SPSS Statistics 17, 18 and 19: A Guide for Social Scientists. Hove: Psychology Press.

Calcaterra, R. M. (2011) *New Perspectives on Pragmatism and Analytic Philosophy*. Rodopi.

Cameron, R. (2008) 'Mixed Methods in Management Research: Has the Phoenix landed? ' *22nd Annual Australian & New Zealand Academy of Management (ANZAM) Conference*, Auckland.

Cameron, R. and Miller, P. (2010) 'Introducing mixed methods in applied business research training', paper presented to Managing and Marketing Organizations in an Era of Global Economic Uncertainty and Environmental Complexity: Academy of World Business, *Marketing and Management Development (AWBMAMD) Conference*, Finland.

Cameron, R. and Miller, P. (2011) 'Mixed methods in business and management: a call to the first generation', *Journal of Management and Organization*.

Campbell, A. F. (2007) 'How to set up a technology transfer office: experiences from Europe'. In *Intellectual Property Management in Health and Agricultural Innovation: A Handbook of Best Practices*, vol. 1, edited by Krattiger, R. T., Mahoney, L., Nelsen, J. A., Thomson, A. B., Bennett, K., Satyanarayana, G. D., Graff, C., Fernandez and Kowalski, S. P. Oxford, UK, and Davis, California: Centre for the Management of Intellectual Property in Health Research and Development (MIHR) and Public Intellectual Property Resource for Agriculture (PIPRA). pp. 559–66.

Cao, X. F. (2005) 'Psychological analysis in motivate enthusiasm of the staff', *Journal of Inner Mongolia science and technology*, No.21, pp.72-73.

Carver, R. H. and Nash, J. G. (2011) *Doing Data Analysis with SPSS: Version 18*, Cengage Learning.

Castka, P., Sharp, J. M. and Bamber, C. J. (2003) 'Assessing teamwork development to improve organizational performance', Measuring Business Excellence, Vol. 7 No. 4, pp. 29-36.

CDC. (2009) *Underground Coal Mining Disasters and Fatalities--United States, 1900—2006*. Available at: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5751a3.htm (Accessed: 15 January 2010).

Cha, D. J. (2012) *Challenges and Observation of China's Energy*. Available at:

http://www.cgness.pku.edu.cn/pages/document.aspx?id=05b0e815-1964-49f5-b48b-b56ed90ed0f8 (Accessed: 11 January 2013).

Champoux, J. E. (1996) *Organizational Behavior: Integrating Individuals, Groups, and Processes.* West Publishing Company, St Paul, MN.

Chang, H. Q. (2005) *Relationship of organization culture, knowledge management and organization learning in educational administration*. PhD thesis.

Chao, J. (2008) *Research Technology Transfer Mode in China*

Chen, A. G. et al. (2003) 'A preliminary analysis of the effects of the governments of the developing countries on international technology transfer', *Journal of Soft Science*, No. 2.

Chen, L. and Liu. Z. (2006) *Subcontracting, Independent Brand and Endogenous Incentive*

Chen, Y. (1995) *Teaching material in technology transfer.* Jongli City: Yuan Ze University Press

Chen, Y. S., Lin, M. J. and Chang, C. H. (2009) 'The positive effects of relationship learning and absorptive capacity on innovation performance and competitive advantage in industrial markets', *Industrial Marketing Management*, Vol. 38, pp.152-158.

China Coal Industry Yearbook (2002) Beijing: State Administration of Coal Mine Safety.

China Coal Industry Yearbook (2008) Beijing: State Administration of Coal Mine Safety.

China Coal Industry Yearbook (2009) Beijing: State Administration of Coal Mine Safety.

China Coal Industry Yearbook (2010) Beijing: State Administration of Coal Mine Safety.

China Coal Industry Association (2013) *Report of Chinese Coal Industry.* Available at: http://www.coalchina.org.cn/page/zt/130130/20130128.pdf (Accessed: 9 February 2013).

China General Administration of Customs, (2010) *Report and Import and Export*. Available at: http://www.chinacoop.gov.cn/Item/40249.aspx (Accessed: 25 January 2011).

China State Administration of Coal Mine Safety, (2009) *Requirement and countermeasure China coal mine safety technology.* Available at:

http://www.chinasafety.gov.cn/newpage/newfiles/20090630ppt.ppt (Accessed: 7 January 2010).

China State Administration of Coal Mine Safety (2012) *Safety Situation of Chinese Coal Mining Industry.* Available at: http://www.chinasafety.gov.cn/newpage/newfiles/20121224mkkj03.ppt (Accessed: 1 January 2013).

Churchill, G. A. and Iacobucci, D. (2009) *Marketing research: Methodological foundations.* 10th ed. Cengage Learning.

Clarck, N. G. (1993) 'Industrialisation and Sustainable Development', Sophia University.

Coe, D. T., Helpman, E. and Hoffmaister, A. W. (1997) 'North–South R&D spillovers', *The Economic Journal*, 107(440), pp. 131–149.

Cohen, G. (2003) T*echnology Transfer: Strategic Management in Developing Countries,* Sage.

Cohen, W. M. and Levinthal, D. A. (1990) 'Absorptive capacity: a new perspective on learning and innovation', *Administrative Science Quarterly*, Vol. 35, pp. 128-52.

Coldwell, D. and Herbst, F. (2004) *Business Research, Cape Town*, Juta Academic.

Cole, S. T. (2005) 'Comparing mail and web-based survey distribution methods: results of surveys to leisure travel retailers', *Journal of Travel Research*, Vol. 43, pp. 422-30.

Collis, J. and Hussey, R. (2009) *Business Research: a practical guide for undergraduate and postgraduate students*, second edition. Basingstoke: Palgrave Macmillan.

Cooper, D. and Schindler, P. (2010) Business Research Methods, McGraw-Hill Press.

Corbetta, P. (2003) *Social Research Theory, Methods and Techniques.* London: SAGE Publications.

Couper, M. P. (2000) 'Web surveys: s review of issues and approaches', *Public Opinion Quarterly*, Vol. 64 No. 4, pp.464-94.

Creedy, D., Lijie, W., Xinquan, Z., Haibin, L. and Campbell, G. (2006) 'Transforming China's coal mines: a case history of the Shuangliu mine', Natural Resources Forum 30, pp. 15-26.

Creswell, J. W. (1994) *Research design: Qualitative and quantitative approaches.* Thousand Oaks, CA: Sage.

Creswell, J. W. (2003) *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (2nd edition)*. Thousand Oaks, CA: Sage.

Creswell, J. W. (2009) *Research Design: Qualitative, Quantitative and Mixed Methods and Approaches (3rd Edition).* Thousand Oaks, CA: Sage

Creswell, J. W. and Clark, V. P. (2010) *Designing and Conducting Mixed Methods Research*, Sage.

Crossan, M. M., Lane, H. W. and White, R. E. (1999) 'An organizational learning framework: from intuition to institution', *Academy of Management Review*, Vol. 24 No. 3, pp. 522-37.

Culter, R. S. (1989) 'A comparison of Japanese and US: high-technology transfer practices', *IEEE Transactions of on Engineering Management*, 36(1): pp. 17- 24.

Currall, S. C. and Towler, A. J. (2003) 'Research methods in management and organizational research: toward integration of qualitative and quantitative techniques', in A. Tashakkori, & C. Teddlie (Eds) *Handbook of mixed methods in social and behavioral research*, pp.513-526, Thousand Oaks, CA: Sage.

Daghfous, A. (2004) 'Organizational learning, knowledge and technology transfer: a case study', *Learning Organization*, Vol. 11 Iss: 1, pp.67 – 83.

De, P. K. (2004) 'Gap between strategy and management of technology: a review of Indian Scenario', in Y. A. Hosni and T. Khali (eds), *Management of Technology*. Internet Economy:

Opportunity and Challenges for Developed and Developing Regions of the World. Elsevier ltd.

Debackere, K. and Veugelers, R. (2005) 'The role of academic technology transfer organizations in improving industry science links', *Research Policy*, 34, pp. 321-342.

Deeds, D. L. (2001) 'The role of R&D intensity, technical development and absorptive capacity in creating entrepreneurial wealth in high technology start-ups', *Journal of Engineering & Technology Management,* Vol. 18, pp. 29-47.

Denzin, N. K. and Lincoln, Y. S. (2003) *Collecting and Interpreting Qualitative Materials,* Sage.

Denzin, N. K. and Lincoln, Y. S. (2011) *the SAGE Handbook of Qualitative Research (4th Edition).* SAGE Publications Inc, Beverly Hills, London.

Dewey, J. (1929) *the Quest for Certainty: A Study of the Relation of Knowledge in Action.* Minton, Balch, and Company, New York, NY.

DeVaus, D. (2002) *Surveys in Social Research.* Routledge.

Dillman, D. A. (2007) *Mail and Internet Surveys: the Tailored Design Method,* John Wiley and Sons.

Dosi, G. (1984) *Technological Change and Industrial Transformation*, Macmillan, London.

Dosi, G. (1988) 'The nature of the innovative process', in Dosi, G., Freeman, C., Nelson, R., Silverberg, G. and Soete, L. (eds). *Technical Change and Economic Theory*, London: Printer, pp. 221-238.

Doshi, V. and Khokle, P. (2011) *Impact of Inter-organizational Relationships on Organizational Learning.*

Edmondson, A. C. (2002) 'The local and variegated nature of learning in organizations: a group-level perspective', *Organization Science*, Vol. 13 No. 2, pp. 128-46.

Eisenhardt, K. M. (1989) 'Building theories from case study research', *The Academy of Management Review*, Vol. 14, No. 4, pp. 532-550.

Englehardt, C. S. and Simmons, P. R. (2002) 'Creating an organizational space for learning', *The Learning Organization*, Vol. 9 No. 1, pp. 39-47.

Farrell, T. (1979) 'A tale of two issues', in Girvan, N. (ed), Science and Technology Policy in the Caribbean, *Social and Economic studies*. Vol. 28(1).

Feagin, J., Orum, A. and Sjoberg, G. (1991) *A Case for Case Study*. Chapel Hill, NC: University of North Carolina Press.

Fendt, J., Kaminska-Labbé, R. and Sachs, W. M. (2008) 'Producing and socializing relevant management knowledge: re-turn to pragmatism', European Business Review, Vol. 20 Iss: 6, pp.471 – 491.

Fielding, J. and Fielding, N. (2008) 'Synergy and synthesis: integrating qualitative and quantitative data', in: *Handbook of Social Research Methods*. Sage, pp. 555-571.

Fisher, T. F. and Ranasinghe, M. (2001) 'Culture and foreign company's choice of entry mode: the case of the Singapore building and construction industry', *Construction Management and Economics*, Vol. 19 No. 4, pp. 343-53.

Flick, U. (1998) *An Introduction to Qualitative Research.* Sage Publication.

Foddy, W. (1994) Constructing Questions for Interviews and Questionnaires: Theory and Practice in Social Research. Cambridge, UK: Cambridge University Press.

Fosfuri, A. and Tribo, J. A. (2008) 'Exploring the antecedents of potential absorptive capacity and its impact on innovation performance', *Omega*, Vol. 36, pp. 173-87.

Fowler, F. J. (2009) *Survey Research Methods*, Sage Publications.

Fransman, M. (1986) *Technology and Economic Development*, Wheatsheaf Books.

Frankel, E. G. (1990) *Management of Technological Change, the Great Challenge of Management to the Future*, Kluwer Academic Publishers.

Fuller, M. (1993) 'Dimensions of Gender in a School: Reinventing the Wheel?' in Burgess B., e.(ed). *The Research Process in Educational Settings: Ten Case Studies.* London, the Falmer Press, pp 97-115.

Galbraith, C. S. (1990) 'Transferring core manufacturing technologies in high technology firms', *California Management Review*, 32(4), pp. 56–70.

Galbraith, J. K. (1967) *The New Industrial State*. Boston: Houghton Mifflin.

Ganguli, P. et al. (2009) *Technology Transfer in Biotechnology: A Global Perspective*. Wiley-VCH Verlag GmbH.

Georghiou, L. J. et al. (1986) *Postinnovation performance: technological development and competition*, London: MacMillan.

Gerber, R. (1998) 'How do workers learn in their work?' *The Learning Organization*, Vol. 5 No. 4, pp. 168-75.

Ghauri, P. N. and Grønhaug, K. (2005) *Research Methods in Business Studies: a Practical Guide*, Pearson Education.

Glaser, B. G. and Strauss, A. L. (1967) *the Discovery of Grounded Theory: Strategies for Qualitative Research.* New York: Aldine Publishing Company.

Glesne, C. and Peshkin, A. (1992) *Becoming Qualitative Researchers.* New York: Longman.

Grant, R. M. (1996) 'Toward a knowledge-based theory of the firm', *Strategic Management Journal*, 17, pp. 109-122.

Greene, J. C. (2007) *Mixed Methods in Social Inquiry.* San Francisco: John Wiley and Sons.

Gregory, M. J. (1995) 'Technology management: a process approach', *Journal of Engineering Manufacture*, 209, pp. 347-356.

Guan, J. C., Mok, C. K., Yam, R. C. M., Chin, K. S. and Pun, K. F. (2006) 'Technology transfer and innovation performance: evidence from Chinese firms', *Technological Forecasting and Social Change*, Vol. 73, pp. 666-78.

Gubrium, J. F. and Holstein, J. A. (2001) *Handbook of Interview Research: Context and Method*, Thousand Oaks: Sage.

Gummesson, E. (1991) *Qualitative Methods in Management Research*, London: Sage.

Gummesson, E. (2000) *Qualitative Methods in Management Research*, 2nd (revised), Sage, Thousand Oaks, CA.

Guo, G. (2010) *Strengthen Protection of National Trademark*. Available at: http://chinatopbrands.org/news.aspx?id=522 (Accessed: 10 November 2011).

Gupta, A. K. and Govindarajan, V. (2000) 'Knowledge Flows within the Multinational Corporation', *Strategic Management Journal*, 21, pp. 473-496.

Hair, J. H. Jr., Anderson, R. E., Tatham, R. L. and Black, W. C. (1995) *Multivariate Data Analysis*. Prentice Hall.

Hall, B. P. (2001) 'Values development and learning organization', *Journal of Knowledge Management*, Vol. 5 No. 1, pp. 19-32.

Hamel, G. (1999) 'Bringing silicon valley inside', *Harvard Business Review*, 77(5), pp. 70-84.

Hammersley, M. (1996) 'The relationship between qualitative and quantitative research: paradigm loyalty versus methodological eclecticism', in J.T.E. Richardson (ed.), *Handbook of Research in Psychology and the Social Sciences*. Leicester UK: BPS Books.

Han, V. et al. (2009) 'Applying theory to structure respondents' stated motivations for participating in web surveys', *Qualitative Market Research: An International Journal*, Vol. 12 No. 4, 2009 pp. 428-442, Emerald Group Publishing Limited.

Han, X. Y. (2009) 'Distribution situation of Pingdingshan coal district', *Journal of Zhongzhou Coal*, No. 7.

Hao, Z. (2003) *Turnkey Contract*. Available at: http://www.ndcnc.gov.cn/datalib/2003/NewItem/DL/DL-463741/ (Accessed: 13 November 2008).

Harris, R. G. and Mowery, D. C. (1990) 'Strategies for innovation: an review', *California Management Review*, 32: pp. 7- 16.

Hatten, K. J. and Rosenthal, S. R. (2001) *Reaching for the Knowledge Edge*. AMACOM, New York.

He, B. and Gu, J. (1996) *Chinese Technology Transfer and Technology Progress*. Economy and Management Publishing.

He, J. S. and Si, Y. B. (2010) 'Research on the approaches to promote the development of technology transfer intermediaries in China: the enlightenment from technology transfer practices in U.S, Japan and France', *Journal of China science and technology*, No.1, pp.157-160.

Hedrick, T., Bickman, L. and Rog, D. J. (1993) *Applied Research Design*. Newbury Park, CA: Sage.

Hendriks, P. (1999) 'Why share knowledge, the influence of ICT on the motivation for knowledge sharing', *Knowledge and Process Management*, Vol. 6, No. 2 pp. 91-100.

Hexun, (2008) *Asian American Coal Inc Withdrew Investment*. Available at: http://stock.hexun.com/2008-09-10/108694176.html (Accessed: 15 October 2008).

Hexun, (2011) *Utilization of Methane*. Available at: http://stock.hexun.com/2011-09-

22/133614399.html (Accessed: 23 November 2011).

Hoekman, B. M. (2005) 'Transfer of technology to developing countries: unilateral and multilateral policy options', *World Development*, Vol. 33, No. 10, pp. 1587–1602.

Hofstede, G. H. (2003) *Culture's Consequences: Comparing Values, Behaviours, Institutions, and Organizations across Nations*, SAGE.

Holstius, K. (1993) 'Managing technology transfer, a new success factor in international business operations', *Turku School of Economics and Business Administration*, pp. 42-50.

Hu, J. T. (2006) *National Conference on Science and Technology.* Available at: http://www.gov.cn/jrzg/2006-01/09/content_151571.htm (Accessed: 9 October 2008).

Huang, J. B. (2005) *International Technology Transfer.* Tsinghua University Press.

IRMA, Information Resources Management Association. (2011) *Organizational Learning and Knowledge: Concepts, Methodologies, Tools and applications.* IGI Global snippet.

Jafarieh, H. (2001) *Technology Transfer to Developing Countries: A Quantitative Approach*. PhD thesis, University of Salford, UK.

James, W. (1907) *Pragmatism, a New Name for Some Old Ways of Thinking: Popular Lectures on Philosophy*. New York, NY.

Jasinski, A. H. (2005) *Barriers for Technology Transfer in Transition Economies: Results of Empirical Studies*. School of Management, Warsaw University press.

Jasinski, A. H. (2009) 'Barriers for technology transfer: the case of a country in transition', *Journal of Technology Management in China*, Vol. 4 Iss: 2, pp.119-131

Jia, Y. (2010) *Lewis turning point and China's FDI prospects*. Available at: http://www.worldbank.org/data (Accessed: 15 April 2010).

Jian, Z. et al. (2010) 'Relationship between organization learning and technology transfer performance', *Chinese Journal of Management*, No.5.

Jogulu, U. D. and Pansiri, J. (2011) 'Mixed methods: a research design for management doctoral dissertations', *Journal of Management Research Review*, Vol. 34 No. 6, pp. 687-701.

Johnson, P. R., Heimann, V. L. and O'Neill, K. (2000) 'The wolf pack: team dynamics for the 21st century', *Journal of Workplace Learning: Employee Counseling Today,* Vol. 12 No. 4, pp. 159-64.

Johnson, J. M. (2001) 'In-Depth Interviewing', in Holstein, J. A. and Gubrium, J. F.(eds) *Handbook of Interview Research: Context & Method.* Thousand Oaks: SAGE.

Johnson, R. B. and Onwuegbuzie, A. J. (2004) 'Mixed methods research: a research paradigm whose time has come', *Educational Researcher*, *33*(7), pp. 14-26.

Jolly, V. K. (1997) *Commercializing New Technologies*. Harvard Business School Press, Boston, MA.

Jones, O. and Craven, M. (2000) 'Expanding capabilities in a mature manufacturing firm: absorptive capacity and the TCS', *International Small Business Journal,* Vol. 19, pp. 39-55.

Karatsu, H. (1990) 'Right technology: transferring technology that is needed', *Intersect*, October, pp. 10–13.

Kaynak, E. (1985) 'Transfer of technology from developed to developing countries: some insights from turkey', In A. C. Samli (Ed.), *Technology Transfer: Geographic, Economic, Cultural, and Technical Dimensions*. Westport, Conn: Quorum.

Khalil, T. (2000) *Management of Technology: The Key to Competitiveness and Wealth Creation.* McGraw-Hill, United State of America.

Kidder, L. and Judd, C. M. (1986) *Research Methods in Social Relation, Fifth Edition*. New York: CBS Publishing.

Kim, D. H. (1993) 'The link between individual and organizational learning', *Sloan Management Review*, Fall, pp. 37-50.

King, N. and Horrocks, C. (2009) Interviews in qualitative research. SAGE Publications Ltd.

Kirkland, J. (1999) *Introduction: Barriers to International Technology Transfer*. Dordrecht: Kluwer Academic Publishers.

Kumaraswamy, M. M. and Shrestha, G. B. (2002) 'Targeting ‘technology exchange’ for faster organizational and industry development', *Building Research and Information*, Vol. 30 No. 3, pp. 183-95.

Lai, W. H. and Tsai, C. T. (2009) 'Fuzzy rule-based analysis of firm’s technology transfer in Taiwan’s machinery industry', *Journal of Expert Systems with Applications*, No.36, pp.12012-12022.

Lai, W. H. (2011) 'Willingness-to-engage in technology transfer in industry–university collaborations', *Journal of Business Research*, No. 64, pp. 1218–1223.

Lan, P. and Young, S. (1996) 'International technology transfer examined at technology component level: a case study in China', *Technovation*, 16 (6), pp. 277-286.

Lane, P. J. and Lubatkin, M. (1998) 'Relative absorptive capacity and inter-organizational learning', *Strategic Management Journal*, Vol. 19, pp. 461-477.

Lane, P. J., Koka, B. R. and Pathak, S. (2006) 'The reification of absorptive capacity: a critical review and rejuvenation of the construct', *The Academy of Management Review*, Vol. 31 No. 4, pp. 833-63.

Larsson, R., Bengtsson, L., Henriksson, K. and Sparks, J. (1998) 'The inter-organizational learning dilemma: collective knowledge development in strategic alliances', *Organization Science*, 9(3), pp. 285-305.

Law of the People’s Republic of China on Chinese-Foreign Equity Joint Ventures, (2001) Available at: http://www.mofcom.gov.cn/article/b/f/200207/20020700031411.shtml (Accessed: 6 October 2008).

Law of the People's Republic of China for Countering Unfair Competition, (1993) Available at: http://www.rrting.com/res/sentence/law/unfair.htm (Accessed: 15 October 2008).

Lawrence, T. B., Mauws, M. K. and Dyck, B. (2005) 'The politics of organizational learning: integrating power into the 4I framework', *The Academy of Management Review*, Vol. 30, No. 1, pp. 180-91.

Lazonick, W. (2005) 'The innovative firm', in Jan Fagerberg, David Mowery, and Richard Nelson, eds., *the Oxford Handbook of Innovation*, Oxford University Press, pp. 29-55.

Leonard-Barton, D. (1995) *Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation*. Boston, MA, Harvard Business School Press.

Leung, H., Thorburn, J., Chau, E. and Tang, S. (1991) 'Contractual relations, foreign direct investment and technology transfer: the case of China', *Journal of International Development*, March, pp. 277-291.

Lewis, A. (2004) *Arthur Lewis' contribution to development thinking and policy.* Available at: http://www.econ.yale.edu/growth_pdf/cdp891.pdf (Accessed: 17 October 2008).

Li, E. (2005) *Operation and Management of Transnational Corporation*, Tsinghua University Publishing.

Li, R. F. et al. (2009) 'Influencing factors to extraction efficiency of surface goaf hole', *Journal of China Coal Society*, Vol.34, No.7, pp.932-951.

Li, R. R. (2011) *Discussion of the State-owned Enterprise.* Available at: http://www.shgzw.gov.cn/gzw/detail9.jsp?main_colid=97&top_id=9&main_artid=16981 (Accessed: 12 February 2012).

Li, Y. Z. (2005) *Coal mines are facing the challenge.* Available at: http://www.chinasafety.gov.cn/zuixinyaowen/2005-06/19/content_107281.htm (Accessed: 17 October 2008).

Liang, Y. H. and Lu, D. (2008) 'Construction circular economy development model in coal-oriented city: the case in Pingdingshan city', *Journal of China Mining Magazine*, No. 6.

Liao, L. F. (2006) 'A learning organization perspective on knowledge-sharing behaviour and firm innovation', *Journal of Human Systems Management*, Vol.25, No.4.

Liao, S. H., Fei, W. C. and Chen, C. C. (2006) 'The relationships among knowledge sharing, absorptive capacity and innovation capability: an empirical study of Taiwan knowledge-intensive industries', *Journal of Human Resource Management*, Vol.6 No.2, pp. 1-21.

Liebeskind, J. P. (1996) 'Knowledge, strategy, and the theory of the firm', *Strategic Management Journal*, 17, pp. 93-107.

Lihua, R. (2001) 'Technology Transfer in International Joint Venture Projects in China', *Ph.D. Thesis*, University of Northumbria at Newcastle.

Lihua, R. (2004) *Technology and knowledge transfer in China*. Ashgate Publishing Ltd.

Lihua, R. and Khalil, T. M. (2006) 'Technology management in China: a global perspective and challenging issues', *Journal of Technology Management in China*, Vol. 1 No. 1, pp. 9-26. Emerald Group Publishing Limited.

Lihua, R. and Sun, W. (2010) 'Examining China's Technology Strategy of Marketing in Exchange for Technology', *Journal of Technology Management in China*, Volume 4, Number 3, pp. 192-194, ISSN 1746-8779, Emerald Insight.

Lihua, R. and Xie, W. (2009) 'What will make China an innovation-oriented country? ' *Journal of Knowledge Based Innovation in China*, ISSN 1756-1418, Emerald Insight, 1(1), pp.8-15.

Lim, D. and Klobas, J. (2000) 'Knowledge management in small enterprises', *The Electronic Library*, Vol. 18 No. 6, pp. 420-32.

Lin, B. W. (2003) 'Technology transfer as technological learning: a source of competitive advantage for firms with limited R&D resources', *Journal of R&D Management*, Volume 33, Issue 3, pp.327–341.

Lin, B. W. and Berg, D. (2001) 'Effects of cultural difference on technology transfer projects: an empirical study of Taiwanese manufacturing companies', *International Journal of Project Management*, Vol. 19 No. 5, pp. 287-93.

Lincoln, A. (1859) *Commercializing Property Rights in Inventions.* Available at: http://www.law.gmu.edu/assets/files/publications/working_papers/1127CommercializingPropertyRights.pdf (Accessed: 15 November 2008).

Liu, J. and Li. Y. J. (2005) 'Emerging technologies, technical uncertainty and some suggestions for the enterprises', *Theory and Reform*, Vol.5.

Liu, J. et al. (2008) 'Technological innovation and organizational learning: a case study on dynamics of a technological innovator network', *the Proceedings of the 6th Globelics International Conference*, Mexico City, Mexico.

Liu, L. J. (2006) *Case study of technology innovation model of US, Japan and Korea.* Available at: http://www.bic.cas.cn/hzkw/gjkjdt/2006/200906/P020090615555540364499.pdf (Accessed: 6 December 2008).

Liu, Z. (2008) *Innovation process and the landscape model of technological innovation in China's coal industry.* Available at: http://doc.mbalib.com/view/ed2603b614208b9e2b783ee44ba9b17e.html (Accessed: 15 June 2009).

Lohman, M. C. (2005) 'A survey of factors influencing the engagement of two professional groups in informal workplace learning activities', *Human Resource Development Quarterly*, 16(4), pp. 501-527.

Lubit, R. (2001) *Tacit Knowledge and Knowledge Management: Keys to Sustainable Competitive Advantage.*

Lundvall, B. Å. (1985) *Product Innovation and User-Producer Interaction*, Aalborg, Aalborg University Press.

Lundvall, B. A. and Vinding, A. L. (2004) 'Product innovation and economic theory-user-producer interaction in the learning economy', *Research on Technological Innovation and Management Policy*, 8, pp. 101-128.

Macho-Stadler, I., Pérez-Castrillo, D. and Veugelers, R. (2007) 'Licensing of university inventions: the role of a technology transfer office'. *International Journal of Industrial Organization*, 25, pp. 483-510.

Madu, N. C. (1989) 'Transferring technology to developing countries-critical factors for success'. *Long Range Plan*; 22(4), pp. 115–24.

Mao, Q. (2012) *Issue and Countermeasures Analysis of Chinese Intellectual Property Right Protection in International Trade.*

Mair, R. (2004) *Knowledge Management System*, Berlin, DE: Springer-Verlag.

Maitland, A. (1999) 'Management of knowledge management: lessons can be learned failed attempts to capture and use employees' knowledge', *Management and Technology*, The Financial Times.

Malik, K. (2002) 'Aiding the technology manager: a conceptual model for intra-firm technology transfer', *Technovation*, Vol. 22 No. 7, pp. 427-36.

Mansfield, E. (1975) 'International technology transfer: forms, resource requirements and policies', *American Economic Review*, Vol. 65. pp. 372-376.

Mansfield, E., Romeo, A., Schwartz, M., Teece, D. Wagner, S. and Brach, P. (1982) *Technology Transfer, Productivity and Economic Policy*. Norton & Company, New York.

Mark, T. (1889) *Science Quotes by Mark Twain.* Available at: http://www.todayinsci.com/T/Twain_Mark/TwainMark-Quotations.htm (Accessed: 12 June 2009).

Marsden, P. V. and Wright, J. D. (2010) *Handbook of survey research*. Emerald Group Publishing.

McAulay, L., Russell, G. and Sims, J. (1997) 'Tacit knowledge for competitive advantage'. *Management Accounting*, Dec, 75, (11), pp. 36-37.

McCullough, D. (1998) 'Web-based market research: the dawning of a new age', *Direct Marketing*, Vol. 61 No. 8, pp. 36-8.

McInerney, C. and LeFevre, D. (2000) 'Knowledge managers: history and challenges'. In C. Prichard et al. (Eds.), *Managing knowledge: Critical investigations of work and learning*. London: Macmillan Business, pp.1-19.

McNabb, D. E. (2008) Research Methods in Public Administration and Nonprofit Management: *Quantitative and Qualitative Approaches*. M.E. Sharpe.

Megantz, R. C. (2002) *Technology Management: Developing and Implementing Effective Licensing Programs*. New York: John Wiley & Sons.

Miles, D. (1995) 'Constructive change, managing international technology transfer',

International Labour Office, Geneva.

Miles, M. B. and Huberman, A. M. (1994) *Qualitative Data Analysis: An Expanded Sourcebook* (2nd.). Thousand Oaks, CA: Sage.

Miller, K. et al. (2011) 'An exploratory study of retaining and maintaining knowledge in university technology transfer processes', *International Journal of Entrepreneurial Behaviour & Research*, Vol. 17 Iss: 6, pp. 663 – 684.

Mills, A. J. et al. (2010) Encyclopedia of research design. Second Volume, Sage.

Mnaas, C. (1990) *Technology Transfer in the Developing Countries.* London: The Macmillan Press Ltd.

Molina-Azorín, J. F. (2011) 'The use and added value of mixed methods in management research', *Journal of Mixed Methods Research*, vol. 5, no.1, pp.7-24.

Moser, C. A. and Kalton, G. (1989) *Survey Methods in Social Investigation.* Aldershot: Gower.

Nan, L. L. And Zhu, J. M. (2010) 'Problems and its solution in the construction of large coal producing bases', *Journal of China Coal*, No. 8.

National Bureau of Statistic, (2005) *Foreign investment and merger in China*. Available at: http://stats.dl.gov.cn/view.jsp?docid=10351 (Accessed: 25 October 2008).

Nelson, D. L. and Quick, J. C. (2003) *Organizational Behaviour: Foundation, Realities and Challenges (4th ed.)*. Australia: Thomson South-Western.

National Mandatory Policies, (2010) *Notice of General Office of State Council*. Available at: http://app2.ah.gov.cn/zfgb/gbcontent.asp?id=4980 (Accessed: 15 March 2011).

Nonaka, I. and Takeuchi, H. (1995) *the Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*. Oxford University Press, London.

Odigie, H. (2012) Technology Transfer Strategies and Practices in Nigerian Construction Organizations. PhD thesis. University of Salford.

Odigie, H. A. and Lihua, R. (2008) 'Unlocking the Channel of Tacit Knowledge Transfer', *Proc. of CAMOT 2008 International Conference*, October 21-23, UIBE, Beijing.

OECD, (1996) 'OECD Benchmark Definition of Foreign Direct Investment', *Paris: Organization for Economic Cooperation and Development*, pp.7-8.

Opinions about Accelerating Drainage and Utilization of Coal Seam Methane. (2006) *Opinions of General Office of State Council*. Available at: http://www.gov.cn/xxgk/pub/govpublic/mrlm/200803/t20080328_32517.html (Accessed: 10 October 2008).

Oppenheim, A. N. (2000) *Questionnaire Design, Interviewing and Attitude Measurement.* London: Continuum International Publishing Group Ltd.

Ounjian, M. L. and Carne, B. (1987) 'A study of the factors which affect technology transfer in a multiplication multi-business unit corporation', *IEEE Transactions on Engineering Management* EM-34 (3), pp. 194–201.

Owens, N. (2012) *the Effect and Influence of Gatekeepers on Technology Transfer in Institutes of Technology in Ireland*. PhD thesis, Waterford Institute of Technology.

Pan, S. L. and Scarbrough, H. (1999) 'Knowledge management in practice: an exploratory case study'. *Technology Analysis & Strategic Management*, 11(3), pp. 359-374.;

Pan, W. and Huang, L. (2008) 'Technology Transfer of the Policies of Supporting Enterprises in the United States and its Enlightenment', *Journal of Harbin University of Commerce,* No.3

Patent Cooperation Treaty (PCT) of World Intellectual Property Organisation (WIPO), (1970) *Summary of the Patent Cooperation Treaty*. Available at: http://www.wipo.int/treaties/en/registration/pct/summary_pct.html (Accessed: 25 October 2008).

Patton, M. (1990) *Qualitative Evaluation and Research Methods.* Sage, London.

Pavitt, K. (2005) 'Innovation Processes', in: Fagerberg, et al (eds.): *The Oxford Handbook of Innovation*, pp. 86-114, Oxford: Oxford University Press.

Payne, S. L. (1951) *the Art of Asking Questions.* Princeton University Press, Princeton New Jersey.

Peirce, C. S. (1992) *the Essential Peirce: Selected Philosophical Writings*, Vol. 1, Indiana University Press, Indianapolis, IN (1867-1893).

Peirce, C. S. (1998) *the Essential Peirce: Selected Philosophical Writings*, Vol. 2, Indiana University Press, Indianapolis, IN (1893-1913).

Piekkari, R. (2011) *Rethinking the Case Study in International Business and Management Research*, Edward Elgar Publishing.

Pink, D. H. (2009) *Drive: The Surprising Truth about What Motivates Us*. Penguin Group.

Phaal, R. et al, (2001) 'Technology management process assessment: a case study', *International Journal of Operations & Production Management*, Vol. 21 Iss: 8, pp. 1116 – 1132.

Prasad, P. (2005) *Crafting Qualitative Research: Working in the Postpositivist Traditions.* Armonk, N.Y. M.E. Sharpe.

Polanyi, M. (1967) *the Tacit Dimension*. New York: Anchor Books.

Porter, M. C. (1988) 'The Technological Dimension of Competitive Strategy', in Burgelman, R. A., & Maldique, M. A., (Eds.), *Strategic Management of Technology and Innovation*, Homewood III, Irwin, pp. 211-232.

Radosevic, S. (2004) *Foreign Direct Investment and Alliances in Global Industrial Integration of Electronics in Central Europe: From production to technological integration.*

RCUK, (2006) *Independent External Challenge Report to Research Councils UK, Knowledge Transfer in the Eight Research Councils.* London: Research Councils UK.

Regulations of the People's Republic of China on Administration of Technology Introduction Contracts, (1987) Available at: http://www.yanmon.com/swls/xgfg/flfg/200609/5093.html (Accessed: 27 October 2008).

Rebentisch, E. S. (1994) 'New Insights into the International Technology Transfer Process', *Report of Technology and Management Innovation Division,* Massachusetts: MIT. Available at: http://mit.edu/erebenti/www/TRANSPAP.pdf (Accessed: 23 October 2008).

Rebentisch, E. S. (1995) *Knowledge in Flux: the Transfer of Technology and Practice in an International Joint Venture.* PhD thesis. Available at: http://mit.edu/erebenti/www/dissn.pdf (Accessed: 25 October 2008).

Remedios, R. and Boreham, N. (2004) 'Organization learning and employees' intrinsic motivation', *Journal of Education and Work*, Vol. 17 No. 2, pp. 219-35.

Ridder, H., Hoon, C. and McCandless, A. (2009) 'the theoretical contribution of case study research to the field of strategy and management', in Donald D. Bergh, David J. Ketchen, (2009) Research Methodology in Strategy and Management, Emerald Group Publishing, Vol. 5, pp.137-178.

Robson, C. (2002) *Real World Research: A Research for Social Scientist and Practitioner – Researchers*. Blackwell Publishers, Oxford, UK.

Robinson, T., Clemson, B. and Keating, C. (1997) 'Development of high performance organizational learning units', *The Learning Organization*, Vol. 4 No. 5, pp. 228-34.

Rosenberg, N. (1982) *Inside the Black Box: Technology and Economics*. Cambridge University Press, Cambridge.

Roster, C.A., Rogers, R.D., Hozier, G. C., Baker, K. G. and Albaum, G. (2007) 'Management of marketing research projects; does delivery method matter anymore in survey research?' *Journal of Marketing Theory and Practice*, Vol. 15 No. 2, pp. 127-45.

Rubenstein, A. H. (2007) 'Technical information, technical assistance, and technology transfer—the need for a synthesis', *R&D Management Journal*, Volume 6 Issue S1, Pages 145 - 150, Blackwell Publishing Ltd.

Russ-Eft, D. et al. (1999) 'Standards on ethics and integrity', Arlington, VA: Academy of Human Resource Development Annual conference proceedings. pp. 1237-1250.

Saad, M. (2003) *Development through technology transfer: creating new organizational and cultural understanding*. Intellect.

Salkind, N. J. (2010) Encyclopedia of research design. First Volume, Sage.

Samli, A. C. (1985) *Technology Transfer: Geographic, Economic, Cultural, and Technical Dimensions*. Quorum Books

Saunders, M. et al. (2008) Research Methods for Business Students. Pearson Education.

Schaefer, D. R. and Dillman, D. A. (1998) 'Development of a standard email methodology', *Public Opinion Quarterly,* Vol. 62 No. 3, pp. 378-97.

Schell, C. (1992) *the Value of the Case Study as a Research Strategy*. Manchester Business School. Available at: http://www.finance-mba.com/Case%20Method.pdf (Accessed: 16 April 2009).

Schleirfer, A. and Bell, D. (1995) *Data Analysis, Regression and Forecasting*. Course Technology Inc, Cambridge, MA.

Schmidt, W. C. (1997) 'World Wide Web survey research: benefit, potential problems and solutions', *Behavior Research Methods,* Instruments, and Computers, Vol. 29, pp. 274-279.

Sekaran, U. and Bougie, R. (2009) *Research Methods for Business: A Skill Building Approach (5th Edition)*. Chichester: Wiley Publishers.

Senge, P. (1990) *the Fifth Discipline: The Art and Practice of the Learning Organization*. Doubleday/Currency, New York, NY.

Sheng, M. L.et al (2013) 'Knowledge barriers, knowledge transfer, and innovation competitive advantage in healthcare settings', *Management Decision,* Vol. 51 No. 3, pp. 461-478

Shendong, (2007) *Development of State-owned Enterprises*. Available at: http://theory.people.com.cn/GB/49154/49155/5877744.html (Accessed: 12 April 2009).

Shi, Y. (1998) *Chinese firms and technology in the reform era.* London: Routledge.

Siachou, E. and Ioannidis, A. (2009) 'Questioning the Positive Effect of External Knowledge Transfer Incurred by Industry Attractiveness: the Case of Mobile Virtual Network Operators (MVNOs) ', *Journal of Knowledge Management*, Volume 7 Issue 2, pp267 – 276.

Simon, H. A. (1991) 'Bounded rationality and organizational learning', *Organization Science,* Vol. 2 No. 1, pp. 125-32.

Simonin, B. L. (1999) 'Ambiguity and the process of knowledge transfer in strategic alliances', *Strategic Management Journal*, Vol. 20 No. 7, pp. 595-623.

Sina, (2008) *Choices of Foreign-Capital Enterprises*. Available at: http://finance.sina.com.cn/chanjing/b/20080826/13435237985.shtml (Accessed: 5 January 2009).

Spann, M. S., Adams, M. and Souder, W. E. (1995) 'Measures of technology-transfer effectiveness — key dimensions and differences in their use by sponsors, developers and adopters'. *IEEE Transactions on Engineering Management*, 42 1, pp. 19–29.

Sina, (2013) *Current Price of Coal Industry.* Available at: http://finance.sina.com.cn/money/future/futuresnyzx/20130328/082614979310.shtml (Accessed: 30 March 2013).

Stake, R. (1995) *The Art of Case Research*. Thousand Oaks, CA: Sage Publications.

Stanton, J. M. (1998) 'An empirical assessment of data collection using the internet', *Personnel Psychology*, Vol. 51 No. 3, pp. 709-25.

State Administration of Work Safety, (2011) *Situation of National Safety Production*. Available at: http://www.chinasafety.gov.cn/newpage/Contents/Channel_20587/2011/0113/120728/content_120728.htm (Accessed: 6 February 2011).

State Council about Prevention Coal Mine Accident Special Provisions, (2005) Available at: http://www.gov.cn/yjgl/2005-09/25/content_70002.htm (Accessed: 7 November 2008).

Stevens, J. P. (2007) Intermediate Statistics: A Modern Approach. Lawrence Erlbaum Associates.

Stewart, C. T. Jr. (1987) 'Technology transfer vs. diffusion: A conceptual clarification'. *Journal of Technology Transfer*, 12(1): pp. 71 - 79.

Stewart, F. (1979) 'International Technology Transfer: Issues and Policy Options', *Staff Working Paper No. 344*, Washington DC: World Bank.

Stim, A. R. (2009) *Patent, Copyright & Trademark (NOLO), 10th Edition.*

Sumanth, D. and Sumanth, J. (1996) 'The ‘Technology Cycle’ Approach to Technology Mananagement', *Handbook of Technology Management.*

Sun, P. Y. T. and Scott, J. L. (2005) 'An investigation of barriers to knowledge Transfer', *Journal of Knowledge Management*, VOL. 9, NO. 2 2005, pp. 75-90.

Sun, W. S. (2011) *Avoiding Four Kind of Officialdom*. Available at: http://opinion.people.com.cn/GB/8213/214664/14155124.html (Accessed: 17 January 2012).

Swanson, R. A. and Holton, E. F. (1997) *Human Resource Development Research Handbook: Linking Research and Practice*. San Francisco: Berrett-Koehler.

Szulanski, G., Cappetta, R. and Jensen, R. J. (2004) 'When and how trustworthiness matters: knowledge transfer and the moderating effect of causal ambiguity', *Organization Science*, Vol. 15 No. 5, pp. 600-13.

Tashakkori, A. and Teddlie, C. (1998) *Mixed Methodology: Combining Qualitative and Quantitative Approaches*. Thousand Oaks, CA: Sage.

Tashakkori, A. and Teddlie, C. (2003) *Handbook of Mixed Methods in Social and Behavioral Research*, Thousand Oaks, CA: Sage.

Tashakkori, A. (2006) *Mixed Methodology: Combining Qualitative and Quantitative Approaches.* Sage.

Teddlie, C. and Tashakkori, A. (2008) *Foundations of Mixed Methods*. Sage, Thousand Oaks, California.

Teece, D. J. (1977) 'Technology transfer by Multinational firms: the resource cost of transferring technological know-how', *Economic Journal*, 87, pp. 242-61.

Tellis, W. (1997) 'Introduction to Case Study', *the Qualitative Report*, Volume 3, No. 2.

Tesch, R. (1990) *Qualitative research: Analysis and Software Tools*. Falmer, London.

The State Intellectual property Office of China, (2006) *Protection of Intellectual property Right*. Available at: http://www.sipo.gov.cn/sipo2008/mtjj/2006/200804/t20080401_362009.html (Accessed: 25 November 2008).

The International Chamber of Commerce, (2002) *Policies of ICC*. Available at: http://www.iccwbo.org/uploadedFiles/ICC/policy/competition/Statements/Comments%20on%20Transfer%20of%20Technology%20Block%20Exemption%20-%20European%20Commission%20evaluation%20report.pdf (Accessed: 28 November 2008).

The United States Patent and Trademark Office, (2010) *An alphabetized, hyperlinked glossary of terms used on the USPTO web site*. Available at: http://www.uspto.gov/main/glossary/index.html#trademark (Accessed: 21 March 2011).

Thorpe, R., Easterby-Smith, M., Lowe, A. and Jackson, P. R. (2008) *Management Research.* Sage.

Todorova, D. and Durisin, B. (2007) 'Absorptive capacity: valuing a reconceptualization', *Academy of Management Review*, Vol. 32 No. 3, pp. 774-86.

Tornatzky, L. and Fleischer, M. (1990) *the Processes of Technological Innovation*, Lexington: Lexington Books.

Trademark Law of the People's Republic of China, (2001) Available at: http://e.3edu.net/flyy/E_4966.html (Accessed: 14 November 2008).

Trochim, W. M. K. and Donnelly, J. P. (2006) Research Methods Knowledge Base. Cengage Learning.

Tsai, W. (2001) 'Knowledge transfer in intra-organizational networks: effects of network position and absorptive capacity on business unit innovation and performance', *The Academy of Management Journal*, Vol. 44, pp. 996-1004.

Tucker, A. L., Edmondson, A. C. and Spear, S. (2002) 'When problem solving prevents organizational learning', J*ournal of Organizational Change Management*, Vol. 15 No. 2, pp. 122-37.

Tull, D. S. and Hawkins, D. I. (1993) *Marketing Research: Measurement and Method: A Text with Cases, Sixth Edition*. New York, Macmillan.

Tyre, M. J. and Hauptman, O. (1992) 'Effectiveness of Organizational Responses to Technological Change in the Production Process', *Organization Science* (3:3), pp. 301-320.

UK Higher Education Academy, (2012) *Mathematics, Statistics and Operational Research: National Student Survey Discipline Report.* Available at: http://www.heacademy.ac.uk/assets/documents/Surveys/MSOR_NSS_Discipline_Report.pdf (Accessed: 10 November 2012).

UNCTAD World Investment Report, (2010) Available at: http://unctad.org/en/Docs/wir2010_en.pdf (Accessed: 5 December 2010).

UNCTC, (1987) *Transnational Corporations and Non-fuel Primary Commodities in Developing Countries*. New York: United Nations.

UNIDO (United Nations Industrial Development Organisation), (1979) *Guidelines for Evaluation of Transfer of Technology Agreements.* United Nations, New York.

United Nations Conference on Trade and Development, (1987) *Transnational Corporations and Technology Transfer: Effects and Policy Issues.* United Nations, New York.

United Nations Conference on Trade and Development, (2001) *Transfer of Technology.* Available at: http://www.unctad.org/en/docs/psiteiitd28.en.pdf (Accessed: 16 November 2008).

United Nations Framework Convention on Climate Change, (2012) *Benefits of the Clean Development Mechanism.* Available at: http://cdm.unfccc.int/about/dev_ben/ABC_2012.pdf (Accessed: 1 December 2012).

United Nations Industrial Development Organization, (2008) *Patterns of Internationalization for Developing Country Enterprises: Alliances and Joint Ventures*. Available at: http://www.unido.org/fileadmin/user_media/Publications/documents/Patterns_of_internationalization_for_developing_country_enterprises_contents.pdf (Accessed: 22 November 2008).

United Nations Industrial Development Organization, (1999) *In-Depth Evaluation of Selected UNIDO Activities on Development and Transfer of Technology: Transfer of Technology in Subcontracting.* Available at: http://www.unido.org/fileadmin/import/userfiles/puffk/dtt-com499.pdf (Accessed: 9 November 2008).

US Constitution Article 1 Section 8 Clause 8. Available at: http://press-pubs.uchicago.edu/founders/tocs/a1_8_8.html (Accessed: 3 November 2008).

US Energy Information Administration, (2012) Total Primary Coal Production**.** Available at: http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=1&pid=7&aid=1 (Accessed: 17 November 2012).

Velasquez, M. (2010) *Philosophy: A Text with Readings*. Cengage Learning.

Vernon, R. (1966) 'International Investment and International Trade in the Product Cycle'. *Quarterly Journal of Economics*, 80, pp. 190-207.

Wang, G. C. S. and Jain, C. L. (2003) *Regression Analysis: Modeling and Forecasting*. Institute of Business Forecasting.

Wang, X. M. (1996) 'Discussion Know-how', *China Academic Journal Electronic Publishing House.*

Wang, Q. Y. (2001) 'China's coal industry: evolution and prospects', *Journal of China Coal*, No. 2.

Wang, X. Y. et al. (2009) 'Literature review: China and foreign technology transfer', *Journal of Science and Technology Management Research*, No. 1.

Wang, Z. H. and Zhao, A. G. (2004) 'the development and strategy choice of China's coal industry', *Journal of China Mining*, No.2.

Wang, J. M. and Zheng, W. L. (2008) 'Application of management in coal mining enterprise: a case study', *Journal of Management Observer*, No. 15.

Wang, Z. (2010) 'Technical Introduction of Chinese Coal mining Industry', *Journal of Dialectics of Nature*.

Wang, X. M. and Zhou, X. (1999) 'A new strategy of technology transfer to China', *International Journal of Operations & Production Management*, Vol. 19 Iss: 5/6, pp.527 – 538.

Wen, J. B. (2005) *Drainage and Utilization of Methane*. Available at: http://www.chinasafety.gov.cn/zhuantibaodao/2006-04/10/content_172492.htm (Accessed: 7 November 2008).

Wen, J. B. (2006) Shendong is the best coal mine in the world. Available at: http://cjb.newssc.org/html/2009-07/16/content_612709.htm (Accessed: 9 November 2009).

Wexley, K. N. and Yukl, G. A. (1984) *Organizational Behavior and Personnel Psychology.* Richard D. Irwin, Homewood, IL.

White, E. (1983) 'Channels and modalities for the transfer of technology to public enterprises in developing countries', *ICPE Monograph Series*, No. 12.

Whyte, W. F. and Whyte, K. K. (1984) *Learning from the Field: A Guide from Experience.* Beverly Hills: Sage Publications.

Wiig, K. M. (1997) 'Knowledge management: where did it come from and where will it go', *Expert Systems with Applications*, 13(1), pp. 1-14.

Wilson, A. (2006) *Marketing research: An integrated approach*. Gosport: Prentice Hall.

Wilson, J. (2010) *Essentials of Business Research: A Guide to Doing Your Research Project*, Sage.

WIPO, (2004) *Licensing and Technology Transfer*. Available at: http://www.wipo.int/patent-law/en/developments/licensing.html (Accessed: 8 November 2008).

World Coal Association, (2010) *Coal Bed Methane.* Available at: http://www.worldcoal.org/coal/coal-seam-methane/coal-bed-methane/ (Accessed: 5 January 2011).

World Intellectual Property Indicators, (2009) Available at: http://www.wipo.int/freepublications/en/intproperty/941/wipo_pub_941.pdf (Accessed: 19 November 2009).

Worster, A. (2007) 'Understanding linear and logistic regression analyses', *CJEM: Canadian Journal of Emergency Medicine*, Vol. 9, Issue 2.

Wu, W. W. et al. (2010) 'Strategic planning for management of technology of China's high technology enterprises', *Journal of Technology Management in China*, Vol. 5, pp. 6 – 25.

Wu, Z. J. (2008) 'Technology Transfer of Coal Mining Industry', *Journal of Coal Mine Safety*, Vol 4, pp. 74-75.

Xinhua, (2005) *Current Price of Coal*. Available at: http://www.cq.xinhuanet.com/2005-01/31/content_3657556.htm (Accessed: 19 November 2008).

Xu, X. (2007) *Base on International Technology Transfer to study technological innovation of Chinese enterprises*. Available at:

http://doc.mbalib.com/view/c21e2a7603ad4f173c9b536f5159a7da.html (Accessed: 12 April 2009).

Yang, J. H. (2010) 'Major environmental and geological problems in Pingdingshan coal district', *Journal of Mineral Protection and Utilization.*

Yang, X. (2004) *Foreign Direct Investment, Technology Transfer and China's Technology Development.*

Yin, R. K. (1989) *Case study research: Design and methods* (Rev. Ed.). Newbury Park, CA: Sage Publishing.

Yin, R. K. (1994) *Case Study Research: Design and Methods*. Thousand Oaks, CA: Sage.

Yin, R. K. (2003) *Case Study Research: Design and Methods*. London, England: Sage Publications.

Yin, R. K. (2009) *Case Study Research: Design and Methods*. Thousand Oaks, CA: Sage.

Yousef, A. R. (1988) 'the Role of Transfer of Technology in the Pursuance of Technical Progress', in UNCTAD, *Technology Policies for Development and Selected Issues for Action*, United Nations, New York.

Yuan, L. (2010) *Scientific Mining of Coal*. Available at: http://www.cas.cn/xw/zjsd/201102/t20110221_3073262.shtml (Accessed: 15 October 2011).

Zha, X. and Chen, M. (2010) 'Study on early warning of competitive technical intelligence based on the patent map', *Journal of Computers*, VOL.5, NO.2. Available at: http://www.academypublisher.com/ojs/index.php/jcp/article/download/0502274281/1373 (Accessed: 19 November 2010).

Zhao, L. M. and Reisman, A. (1992) 'Toward meta research on technology transfer', *IEEE Transactions on Engineering Management*, 39(1), pp. 13-21.

Zhao, H. J. (2007) 'Government function localization by analyzing the technology transfer', *Journal of Public Administration*, No.10.

Zhao, T. C. (2008) 'Eliminating small-scale coal mines of backward production capacity', *Journal of Energy Technology and Management*, No. 5.

Zhao, T. C. (2010) *Experience-sharing Sessions of Underground Conveying System and Technology Equipment.* Available at: http://www.chinasafety.gov.cn/newpage/Contents/Channel_5372/2010/1218/117976/content_117976.htm (Accessed: 27 December 2011).

Zhang, H. L. (2009) 'Promotion efficiency of firm technology transfer and absorption', Science and Technology Daily. Available at: http://stdaily.com/kjrb/content/2009-12/08/content_132480.htm (Accessed: 9 July 2010).

Zhang, J. W. (2000) *On Knowledge Construction*. Available at: http://www.etc.edu.cn/%E8%AE%BA%E8%91%97%E9%80%89%E6%91%98/%E5%BC%A0%E5%BB%BA%E4%BC%9F/%E7%9F%A5%E8%AF%86%E7%9A%84%E5%BB%BA%E6%9E%84.htm (Accessed: 4 November 2008).

Zhang, Z. J. (2010) 'Probe development of Pingdingshan No.1 coal mine', *Journal of Zhongzhou Coal*, No.9.

Zhou, Z. and Sun, A. Y. (2005) 'Organizational learning based on technological characteristics in process of technology transfer', *Journal of Enterprise Management*, No.7.

Zikmund, W. G. (2003) *Business Research Methods.* Mason, OH: South Western.

Appendix 1 Self-completion Questionnaire

Letter Accompanying Questionnaire (问卷调查说明信)

TECHNOLOGY TRANSFER IN CHINESE COAL MINING INDUSTRY
（技术转移在中国煤炭开采行业）

Dear Sir or Madam（尊敬的先生和女士）,

You are invited to participate in a survey of technology transfer in the Chinese coal mining industry. This survey is part of a doctoral research project at University of Newcastle upon Tyne. This research project has been supported by State Administration of Coal Mine Safety. In this survey, approximately 1000 people will be asked to complete the questionnaire about technology transfer in coal mining industry concerning the factors influencing the effect of international technology transfer. It will take approximately 15-20 minutes to complete the questionnaire. Your participation in this study is completely voluntary. There are no foreseeable risks associated with this project. However, if you feel uncomfortable while answering any questions, you can withdraw from the survey at any point. It is very important for us to learn your opinions. Your survey responses will be strictly confidential and data from this research will be used only for academic purposes. Your information will be coded and will remain confidential. （我们诚挚的邀请您参与中国煤炭行业的技术转移调查，这个调查是英国纽卡斯尔大学博士研究项目的一部分。这项调查也获得了国家煤矿安全监督局的支持，我们邀请了至少1000位志愿者参与这项调查，希望通过这个调查了解影响国际技术转移效果的因素，完成这份问卷最多花费您15-20分钟。您参与这项调查没有任何风险，而且是完全自愿的，如果您在填写问卷时感觉不适，可以随时退出。您填写的信息和您的个人信息我们将严格保密并只供研究使用。）

If you have questions at any time about the survey or the procedures, you may contact:
Qi Li, Newcastle University Business School, 6th Floor, 5 Barrack Road, Newcastle upon Tyne, NE1 4SE, United Kingdom

Thank you very much for your time and support. Please start with the survey now by clicking on the Continue button below.

（我们非常期待您对这个研究的支持，如果您在填写问卷时有什么问题，请您随时联系我，我的地址：李琦，英国纽卡斯尔大学商学院6楼，邮编：NE1 4SE。

再次感谢您的帮助和支持，谢谢。）

Note about the Research Questionnaire (填写问卷注意事项):
In order to clarify some terminology used in this research questionnaire, the following are defined. (为了便于您更好的填写问卷，在填写问卷之前，我将对一些术语做详细的解释。)

- Technology（技术）:

Technology is the making, usage, and knowledge of tools, machines, techniques, crafts, systems or methods of organisation in order to solve a problem or perform a specific function. It can also refer to the collection of such tools and machinery.
（在这个调查中，技术的定义是：关于制造产品、实施工艺流程、提供服务的系统知识，是为了解决一个问题或执行特定的功能。它有时也涉及设备和工艺。）

- International Technology Transfer（国际技术转移）:

International technology transfer can be defined as the "(international) transfer of systematic knowledge for the manufacture of a product, for the application of a process, or for the rendering of a service" (United Nations Conference on Trade and Development, 2001).
（联合国贸发会议曾对技术转移下的定义是：为制造某种产品应用某种工艺流程或提供某种服务而进行的系统知识的转移. 国际技术转移是指系统知识的跨国转移。）

- Licensing (License Agreement) (技术许可贸易或技术许可协议):

Licensing as channel of international technology transfer is a permission granted by the patent owner (transferor: foreign individual or organisation) to another (transferee: large state-owned coal mine) to use the patented invention (technology or equipment) on agreed terms and conditions, while the patent owner (transferor) continues to retain ownership of the patent (World Intellectual Property Organisation, 2011).

- （世界知识产权组织认为许可证贸易是国际技术转移中最为普遍的一种形式，也称为"许可贸易"是指国外的技术出售者将其技术标的物的使用权通过许可证协议或合同的形式销售给技术接受方（大型国有煤矿）的一种贸易方式，但是这项技术的所有权还是属于技术出售方。）

- Effect of International Technology Transfer:

For the purpose of this study, the effect of international technology transfer in coal mining industry have been defined as the extent to the transferee absorbs the transferred technology through licensing, and the degree of the transferee absorbs the knowledge involved in the transferred technology, as well as the use of the absorbed

knowledge to achieve the expected effect that the transferee hopes to through the transferred technology.
（从这个研究的目的而言，煤炭开采行业的国际技术转移的效果是接收方（大型国有煤矿）能够吸收转移技术的效果，也就是接受方（大型国有煤矿）能吸收的转移知识的程度，这种知识是包含在转移技术中的，效果也意味着接收方（大型国有煤矿）有通过转移的技术达到他们预期想要的效果的程度。）

If you want to have a copy of the research report when the research project has been finished, Please leave your email address here:

____

（如果您希望在这个调研完成后，得到一份关于这个研究的报告，请您留下您的电子邮箱，谢谢。）

Section One （第一部分）
Background Information （背景信息）

Please tick [√] the appropriate boxes.

1. How long have been working in the coal mining industry?
（1. 请问您在煤炭行业工作了多久？）
[ ] Less than1 years （不到1年）
[ ] 1-3 years （1-3年）
[ ] 3-5 years （3-5年）
[ ] 5-10 years （5-10年）
[ ] more than 10 years （10年以上）

2. How long have you experienced the licensing?
（2. 请问您有多久的技术许可贸易的经验？）
[ ] less than 6 months （少于 6 个月）
[ ] 6-12 months （6-12 个月）
[ ] 1-3 years （1-3 年）
[ ] 3-5 years （3-5 年）
[ ] More than 5 years （超过 5 年）
[ ] None （没有技术许可贸易的经验）

3. How many projects related to licensing have you ever engaged in? (Exclude the project/s you are doing now)
（3. 不包括您目前正参与的技术许可项目，您以前从事过多少个技术许可项目？）
[ ] 1 （1 个）
[ ] 2 （2 个）
[ ] 3 （3 个）
[ ] More than 3 （超过三个）
[ ] None （没有参与任何项目）

4. What is your present post?
（4. 请问您目前的职位是？）
[ ] General Manager （总经理）
[ ] General Engineer （总工程师）
[ ] Deputy General Manager （副总经理）
[ ] Director （科长）
[ ] Technician （技术人员）
[ ] Team Leader of Miner （采矿队长）
Others (please specify: ________) （其他，请您详细说明）

5. In 2010, the output of your coal mine is:
（5. 请问您所在的煤矿2010年的产量是？）
[ ] Less than 1 million tones （100万吨以下）
[ ] 1 million tons to less than 3 million tons （100-300万吨）
[ ] 3 million tons to less than 5 million tons （300-500万吨）
[ ] 5 million tons to less than 10 million tons （500-1000万吨）
[ ] 10 million tons to less than 30 million tons （1000-3000万吨）

6. Where is your coal mine located? Please specify the province that your coal mine is located.
（6. 请问您所在的煤矿属于哪个省？）
____

Kindly reminder: Please finish the following section based on your last experience on the licensing project of international technology transfer. （友情提示：请根据您上一次的国际技术转移的技术许可经验回答下面的问题，谢谢。）

7. Which party do you belong to in the licensing?
（7. 您在上次的技术许可贸易中是属于？）
[ ] Transferor （技术提供方）
[ ] Transferee （技术接受方）
[ ] Others (please specify: ________) （其他，请您详细说明）

8. Please you evaluate effect of the licensing:
（8. 您怎么评价上次的技术许可的效果？）
[ ] Very good (This means that your coal mine sufficiently absorbed knowledge involved in transferred technology, and achieved the expected effect and innovation based on absorbed knowledge).
非常好的效果（我们矿充分的吸收了转移技术中的知识并达到了预期我们想要通过这项技术达到的效果，我们也基于吸收的知识又进行了创新）
[ ] Good (This means that your coal mine sufficiently absorbed knowledge involved in transferred technology, and achieved the expected effect).
好的效果（我们矿充分的吸收了转移技术中的知识并达到了预期我们想要通过这项技术达到的效果）
[ ] Barely acceptable (This means that your coal mine partially absorbed knowledge involved

in transferred technology, and partially achieved the expected effect).
可以接受的效果（我们矿吸收了一部分转移技术中的知识并达到了一些我们想要通过这项技术达到的效果）
[ ] Poor (This means that your coal mine partially absorbed knowledge involved in transferred technology, and no expected achievement was made).
差的效果（我们矿吸收了一部分转移技术中的知识，但没有达到我们想要通过这项技术达到的效果）
[ ] Very poor (This means that your coal mine cannot absorbed knowledge involved in transferred technology, and no expected achievement was made).
非常差的效果（我们矿不能吸收转移技术中的知识，而且也没有达到我们想要通过这项技术达到的效果）

9. The transferor fulfilled the contractual obligation in the process of licensing.
（9. 在技术许可的过程中，技术提供方履行了合同中他们应尽的责任）
[ ] Strongly agree （非常同意）
[ ] Agree （同意）
[ ] Neutral （不置可否）
[ ] Disagree （不同意）
[ ] Strongly Disagree (非常不同意)

10. The transferor has good cooperation with your coal mine in the process of licensing.
（10. 在技术许可的过程中，技术提供方和我们矿进行了好的合作。）
[ ] Strongly agree（非常同意）
[ ] Agree （同意）
[ ] Neutral （不置可否）
[ ] Disagree （不同意）
[ ] Strongly Disagree (非常不同意)

Section Two （第二部分）
Government （政府）

Please finish the following section based on your last experience on the licensing project of international technology transfer. The following statements deal with different aspects of government and intend to assess the aspects that mostly influence the effect of the licensing. Please tick [√] the box below, indicating how strongly you agree or disagree with each statement. (请根据您上一次的国际技术转移的技术许可经验回答下面的问题，下面的每个问题都是关于政府的各个方面影响国际技术转移的效果，请回答您有多同意或多不同意下面的陈述，请在您同意的选项前打钩)

SA: Strongly Agree （SA: 非常同意）
A: Agree (A: 同意)
N: Neutral (N: 不置可否)

D: Disagree (D: 不同意)
SD: Strongly Disagree (SD: 非常不同意)

		SA 非常同意	A 同意	N 不置可否	D 不同意	SD 非常不同意
11.	The provincial government made innovation strategy to guide my organisation to engage in licensing. (省政府制定了创新战略指导我们煤矿从事技术许可。)					
12.	The provincial government made policies to encourage my organisation to learn know-how for innovation through licensing. （省政府制定了政策鼓励我们矿从技术许可贸易中学习技术诀窍。）					
13.	The provincial government made polices, encouraging the university and state research institutes to assist my organisation to absorb know-how in the process of licensing. （省政府也制定政策鼓励大学和科研院所在技术许可的过程中协助我们矿去吸收知识。）					
14.	The provincial government made polices to encourage my organisation to invest sufficient R&D in the process of licensing. （省政府也制定政策鼓励我们矿在技术许可的过程中充分投资在研发上。）					
15.	The provincial government made relevant regulations of technology transfer to safeguard my organisation to engage in licensing. （省政府也制定了相关的规章去保障我们矿从事技术许可贸易。）					
16.	The provincial government made systematic regulations to protect the IPR of transferor in the licensing. （省政府也制定了系统的规章在技术许可贸易中保护技术提供方的知识产权。）					
17.	The provincial government punished severely IPR violation to safeguard profit of transferor in the licensing. （省政府也严厉的惩罚侵害知识产权的事件以便在技术许可贸易中保障技术提供方的利益。）					
18.	The provincial government made policies to encourage the development of professional TT agencies for service my organisation. （省政府也制定政策鼓励技术转移中介的发展以便为我们矿更好的提供技术转移的服务。）					
19.	The provincial government built appropriate educational system to supply talented individual for					

	my organisation to engage in licensing. （目前的教育体系为我们矿提供了从事技术许可贸易的人才。）					
20.	The provincial government provided financial support when my organisation engages in licensing. （当我们矿从事技术许可贸易时，省政府也给予了财政支持。）					

SECTION Three （第三部分）
Organisation （组织）

Please finish the following section based on your last experience on the licensing project of international technology transfer. The following statements deal with different aspects of your organisation and intend to assess the aspects that mostly affect the effect of technology transfer. Please tick [√] the box appropriately and indicate how strongly you agree or disagree with each statement. (请根据您上一次的国际技术转移的技术许可经验回答下面的问题，下面的每个问题都是关于组织的各个方面影响国际技术转移的效果，请回答您有多同意或多不同意下面的陈述，请在您同意的选项前打钩)

21. Does your organisation have a special department responsible for the licensing?
（21. 您所在的煤矿有一个专门的部门负责技术许可贸易吗？）
[ ] Yes （有）
[ ] No （没有）

If no, which department is responsible for dealing with the activity of licensing in your organisation?
Please specify, ____________________
（如果没有，那请问负责技术许可贸易的部门叫什么名字？请您说明）

22. Which levels of learning is/are adopted in your organisation? Please tick [√] the appropriate boxes (multi-options).
（22. 在上一次的技术许可贸易中，下面哪一种学习类型有被采用在您所在的组织？）
[ ] Individual learning (Individual learns know-how in the process of absorption transferred technology) <system will direct respondents to fill in 34 to 41 if respondents ticked the option>
个人学习（在吸收转移技术的过程中，我们矿通过个人学习去吸收技术诀窍）
[ ] Team learning (Team serve as a learning forum for individuals in the process of absorbing the transferred technology) <system will direct respondents to fill in 42 to 49 if respondents ticked the option>
团队学习（在吸收转移技术的过程中，团队作为一个平台被充分的利用以便个人学习技术诀窍）

[ ] Organisational learning (In the process of absorbing the transferred technology, the organisation adopts various actions to learn know-how to achieve the expected goals and to promote the competitive advantages) <system will direct respondents to fill in 50 to 56 if respondents ticked the option>

组织学习（在吸收转移技术的过程中，组织采用了多种方式去吸收技术诀窍）

[ ] Inter-organisational learning (In the process of absorbing the transferred technology, the organisation learns from the competitor and shares experience with them) <system will direct respondents to fill in 57 to 61 if respondent ticked the option>

组织间学习（在吸收转移技术的过程中，我们的组织学习同类企业的技术转移经验并和同类企业分享技术转移的经验以便更好的吸收技术诀窍）

[ ] All levels have been adopted in your coal mine <system will direct respondents to fill in 34 to 61 if respondent ticked the option>

以上四项都被采用

[ ] All levels have not been adopted in your coal mine <system will direct respondents to fill in next section if respondent ticked the option>

以上四项都没有被采用

Please tick [√] the box below, indicating how strongly you agree or disagree with each statement. （请回答您有多同意或多不同意下面的陈述，请在您同意的选项前打钩。）

SA: Strongly Agree （SA: 非常同意）
A: Agree (A: 同意)
N: Neutral (N: 不置可否)
D: Disagree (D: 不同意)
SD: Strongly Disagree (SD: 非常不同意)

		SA 非常同意	A 同意	N 不置可否	D 不同意	SD 非常不同意
23.	My organisation made innovation strategy before licensing. （在进行技术许可贸易前，我们矿制定了创新导向的战略）					
24.	My organisation built atmosphere of learning new knowledge in the process of licensing. （在技术许可贸易的过程中，我们矿营造了学习新知识的氛					

	围。）					
25.	My organisation arranged professional staff to be responsible for IPR protection of transferor in the process of licensing.（在技术许可的过程中，我们矿安排了专业人员去负责保护技术提供方的知识产权。）					
26.	My organisation arranged appropriate talented individual to manage the process of licensing.（在技术许可的过程中，我们矿安排的合适的人才管理这个过程。）					
27.	My organisation arranged sufficient financial resources to support licensing.（我们矿有充足的专项资金支持技术许可。）					
28.	My organisation built good knowledge communication system for learning the know-how in the process of licensing, such as regular experts lectures.（我们矿营造了好的知识交流体系在技术许可过程中去学习技术诀窍。例如，我们矿有定期的专家讲座。）					
29.	My organisation built good discussion forums for learning the know-how in the process of licensing, such as internal regular seminar.（在技术许可的过程中，我们矿营造了好的讨论平台为学习技术诀窍，例如，内部定期的研讨会。）					
30.	My organisation provided relevant training for me before licensing.（在技术许可贸易前，我们矿为我提供了相关的培训。）					
31.	My organisation arranged professional staff to identify the technology during selecting technology, such as identifying whether the technology suits the local geological condition.（在挑选技术时，我们矿安排专业人员去识别技术。例如，看看技术是不是适合我们矿的地质状况。）					
32.	My organisation invited external professionals or agencies to identify technology during selecting technology, such as identifying whether the technology suits the local geological condition.（在挑选技术期间，我们矿也邀请外部专家和中介去识别技术。例如：识别这项技术是否适合我们矿的情况。）					
33.	My organisation played a positive role in the process of licensing.（我的组织在技术转移中起了非常积极的作用。）					
34.	The organisation built good rewarding system to encourage my learning of the know-how in the process of licensing.（在技术许可过程中，我们矿制定了好的奖励体制去鼓励我们学习技术诀窍。）					
35	I have been effectively managed to learn know-how					

	under specific objectives in the process of licensing.（在技术许可过程中，我有明确的目的并被有效的管理去学习技术诀窍。）					
36.	I am willing to learn the know-how in the process of licensing.（在技术许可的过程中，我愿意学习技术诀窍。）					
37.	I am willing to share the learning experience with my team in the process of licensing.（在技术许可的过程中，我愿意和我的团队分享学习的体验。）					
38.	The team and I have common goals in the process of licensing.（在技术许可中，我的团队和我有共同的目标。）					
39.	I have the clear learning motivation in the process of licensing.（在技术许可的过程中，我有明确的学习动机。）					
40.	I have the capability to learn know-how in the process of licensing.（在技术许可的过程中，我有能力学习技术诀窍。）					
41.	My organisation pays attention to individual learning in the process of licensing.（在技术许可贸易过程中，我的组织很重视个人学习。）					
42.	I am willing to learn the know-how by team unit in the process of licensing.（在技术许可的过程，我愿意以团队为单位学习技术诀窍。）					
43.	The team members and I regularly share the learning progress in the process of licensing.（在技术许可的过程中，我们团队成员和我定期分享学习的进展。）					
44.	The team leader rewarded me when I obtained some learning progress in the process of learning the know-how.（在学习技术诀窍的过程中，当我获得学习进展，我们团队领导会奖励我。）					
45.	The members of my team have the capability to learn the know-how in the process of licensing.（在技术许可的过程中，我们团队成员都有能力学习技术诀窍。）					
46.	My team and organisation have common goals in the process of absorbing the knowledge.（在吸收技术的过程中，我们团队和组织都有共同的目标。）					
47.	I am not afraid to display ignorance in the team learning.（在团队学习中，我不用担心展现无知的一面。）					
48.	The team manager regularly participates in our know-how learning in the process of licensing.（在技术许可的过程中，我们团队的领导定期的参加技术诀窍的学习。）					

49.	My organisation has good team learning in the process of licensing. （在技术许可的过程中，我们矿有好的团队学习。）					
50.	My organisation has good vision for learning the know-how in the process of licensing. （在技术许可的过程中，我们组织有好的学习愿景去学习技术诀窍。）					
51.	My organisation has knowledge background to learn know-how in process of licensing. （在技术许可的过程中，我们组织有好的知识基础去学习技术诀窍。）					
52.	The organisation is willing to share knowledge with my team in the process of learning know-how. （在学习技术诀窍的过程中，我们组织愿意分享知识和我们团队。）					
53.	My organisation has strong desire to absorb know-how in the process of licensing. （在技术许可过程中，我们组织有强烈的意愿去吸收技术诀窍。）					
54.	My organisation invested sufficiently R&D to promote the knowledge accumulation for absorbing know-how in process of licensing. （在技术许可的过程中，我们组织在研发上充分投资以便提升我们的知识积累去更好的吸收技术诀窍。）					
55.	The middle managers participate regularly in the activities of learning know-how in the process of licensing. （在技术许可过程中，中层管理人员定期参与学习技术诀窍的活动。）					
56.	The organisational learning has been given enough attention in my organisation during the process of licensing. （在技术许可的过程中，组织学习有被足够重视在我们矿。）					
57.	My organisation learns the successful licensing experience from other organisations. （我们矿学习其他矿在技术许可贸易上的成功经验。）					
58.	My organisation shares the experience of ITT with other organisations in process of licensing. （在技术许可过程中，我们矿分享技术转移的体验和其它矿。）					
59.	My organisation gains the external support from other organisations in the process of licensing. （在技术许可的过程中，我们矿也获得来自其它煤矿的外部支持。）					
60.	The top manager participates regularly in the activities of learning know-how in the process of licensing. （在技术许可的过程中，我们矿的高层管理者也定期参加我们学习技术诀窍的活动。）					

61.	The inter-organisational learning has been given enough attention in my organisation. （我们矿重视组织间的学习。）					

Section Four （第四部分）
Other information （其他信息）

62. What do you think is/are the most important factor/s influencing the effect of ITT listed above? （您认为在上述提到的因素中哪个或那些最影响技术转移的效果？）

63. Do you have any idea for improving the future ITT in the Chinese coal mining industry from the perspective of government? （您有什么建议关于未来从政府方面改善国际技术转移的效果？）

64. Do you have any idea for improving the future ITT in the Chinese coal mining industry from the perspective of organisation? （您有什么建议关于未来从组织方面改善国际技术转移的效果？）

65. It would be grateful if you could add other aspects affecting the effect of ITT that is not listed above. (如果您能增加一些问卷中未提及但您认为影响国际技术转移效果的因素，我们将非常感谢。)

Thank you for completing this questionnaire. ☺
（谢谢您完成问卷）