

Technology Transfer in Coal Mining Industry in China

Qi Li and Richard Li-Hua

**Newcastle Business School, University of Northumbria at Newcastle
Newcastle upon Tyne, NE1 8ST, the UK**

Abstract

China's open policy started in 1978 is the indication of resurgence that China has been implementing a new technology strategy for its technological capacity building. Technology transfer is recognized as the acquisition, adaptation and use of technological knowledge by an individual, group, or society other than the one that developed the technology. The concept of technology transfer involves more than the capacity to acquire new knowledge, or produce improved production processes, it also encompasses the capacities to link engineering and managerial skills to plan, develop and implement technological capacities to shape and accomplish the strategic and operational objectives of the host organization.

Technology transfer has been a subject of considerable interest to many group, such as government policymakers, international funding agencies, and business executives, because of the close relationship between technology transfer and economic growth, technology transfer has aroused the interest of academic researchers not only from the developing countries but also from developed countries as it concerns both the transferee and the transferor. Technology transfer is shrouded not only in controversy and emotion, but also in considerable confusion, owing to the complexity of "technology" itself and the multiplicity of channels of its "transfer". A difficulty lies in determining what to evaluate, what to transfer, how to transfer and why, since technology transfer has two main dimensions: that from the seller/transferor to the buyer/transferee, and that relating to the effective diffusion and application of the technology.

Reformation towards sustainable development of coal mine industry, one of the pillar industries in China, appeared with little concern on foreign collaboration. Coal production in China, rank the first large in the world in 2006, with the biggest coal production and largest coal consumption, coal industry in China will have significant impact to economic development both nationally and internationally. Coal is certainly a major energy for power supply and household service in China, hence the coal industry and coal related production is coupled with civic and industrialization development closely.

Following literature review, this paper describes the first part of a PhD research project- a structured survey on the current state of technology transfer in China's coal mining industry, which was undertaken in Henan Province, PRC. Henan has been selected because of its representativeness of the main coal production are in the hope to provide epitome of the whole coal mining industry in China, it has been recognized that state-owned coal mine and small coal mine development remain unbalanced in Henan Province, Recognizing various channels of technology transfer in China's coal mining industry nationally and internationally are both exist, it has been strategically significant to identify the appropriateness and effectiveness of technology transfer in order to take account of the development unbalance state-owned coal mine and private small coal mine. We should talk about this later “ order to reduce gas explosion accident” this is too specific.

Key words: Technology Transfer, Knowledge transfer, Tacit knowledge, Coal mine industry of China

Introduction

Chinese's open door policy in 1978 is the indication of resurgence that Chinese start to import foreign knowledge, technology, skills to contribute economic reform, which renunciation the self-reliance dominance. The stunning economic growth in China

since then has proved the technology is the core of economic development. Western advanced technology have not only increased the industrial productivity but also revitalized new industrial in China, it expedited Chinese modernization significantly.

Technology transfer includes not only the “hard,” possibly patentable aspects of production, like the specifications of goods and the mechanistic details of their manufacture, but also the “soft” aspects of business processes, such as organization, marketing, and other types of managerial knowledge and skills (Stewart 1977). Hendryx (1986) also point out that successful transfer of hard technologies often has to be accompanied by the transfer of soft technologies like management know-how. Hence technology transfer is a complex process which not simple replication of technology, but also depends much on the capacity that can be adopt and level of integration with end user’s indigenou condition.

A lot of researches initially emphasize on the structure and outcome that lead to successful technology transfer, but technology in different country or different application will result differently, hence Samli (1985) highlighted that success in technology transfer is related to its appropriateness and effectiveness, neither transfer nor diffusion is completed by the purchase of a sophisticated machine, instead, successful assimilation of technology crucially depends on the adaption of skills and working practices in the recipient firm (Miliband,1990). Regardless how significant the technology could be, it should suit the need of the recipient and with adjustment on the new adoption in order to perform its superiority. And technologies are sensitive to local cultural and environmental condition (Bakuli, 1994).

Technology and Knowledge Transfer

Galbraith (1990) points out that one of the keys to corporate success lies in the efficient exploitation and transfer of knowledge-based assets. Indeed, a technology transfer project is essentially a knowledge accumulation task, which Gupta and

Govind arajan (2000) further disaggregated into knowledge creation, acquisition, and retention (Abdelkader, 2004), in another works, knowledge transfer.

Knowledge transfer is defined as a process through which one unit (e.g., group, department, or division) is affected by the experience of another (Argote, 2000). At the same time, knowledge transfer is also a complex process, because it is often difficult to identify who can handle transfers, what can be transferred and how to transfer. Knowledge is about connection not collection, and that connection ultimately depends on the choice made by individual (Dougherty, 1999). How knowledge transfer from one group to another group depends on the type of knowledge. In a knowledge-based economy, organization is encouraged to obtain advanced knowledge to strengthen the winning position in scorching competition. Many researches share the view that the dominant of technology transfer is the transmission of knowledge. Without knowledge transfer, technology transfer does not take place as knowledge is the key to control technology as a whole. (Li-Hua, 2004).

When Polanyi (1967) first highlight that we know more than we can tell, knowledge have dichotomy classification, explicit knowledge and tacit knowledge, (McAulay, 1997). Explicit knowledge includes documents, drawings, calculations, designs, databases, procedures, manuals, audio and video, and so on. Tacit knowledge includes experience, technique, culture and habit, and so on (Lubit 2001). In comparison, explicit knowledge is more precise and systematic, and it can be record and communicate in the form of literature or codified procedures, hence the explicit knowledge is relatively easy to transfer, tacit knowledge is not. Tacit knowledge is not available as a text and may conveniently be regarded as residing in the heads of those working in a particular organizational context. It involves intangible factors embedded in personal beliefs, experiences, and values (Pan and Scarbrough, 1999). It is can be say that tacit knowledge is existed when the individual are work on the particular aspects, otherwise, it is not even exist.

Due to the globalization, manageable knowledge, in this case, explicit knowledge is easily shared between countries with no limitation on the distance, the tacit knowledge, that will not be shared easily, imposes a big gap among countries. Lubit (2001) considered tacit know-how as a key role in economic growth and competitiveness. The same principle can be applied to individuals, organizations, etc. In the process of technology transfer, tacit knowledge becomes the biggest obstruction.

According to Lubit (2001) Tacit knowledge is the knowledge that people acquire from experience. Hagen (2005) considered tacit knowledge may originate in the mind of individuals in the form of insights, intuitions and is not easily visible and expressible. It is highly personal and is often hard to formalize and share with others. Based on the analysis of the knowledge transferring process, Li-Hua (2004) considered tacit knowledge transfer is considerably more haphazard and it is in this area that knowledge transfer can falter and technology transfer can be impeded. So tacit knowledge transfer is technology transfer key. We have to improve tacit technology transfer. According to Hagen (2005) tacit knowledge is more valuable because it provides context for people, places, ideas, and experiences. Effective transfer of tacit knowledge generally requires extensive personal contact and trust. Polanyi (1967) considered human knowledge by starting from the fact that we know more than we can tell. Knowledge is increasingly being recognized as a vital organizational resource that gives market leverage and competitive strength. Tacit knowledge often consists of habits and culture that we do not recognize or are familiar with in ourselves. In the field of knowledge management, the concept of tacit knowledge refers to a knowledge which is only known by an individual and that is difficult to communicate to the rest of an organization. Tacit knowledge is not easily shared due to its inherent character. Tacit knowledge is not transferable language, text, graphics or symbols that can be clearly expressed, it is very difficult to express it logically, it is the non-verbal intelligence activities results. Tacit knowledge exists in the minds of individuals, it is the main carrier of individuals, it cannot transfer through formal form, for example: school education and medium, because tacit knowledge owners are difficult to express.

But it does not mean that tacit knowledge cannot be transferred; only the transfer of some special way that tacit knowledge need to progress conversion in knowledge transfer process. Figure 1 represents tacit knowledge can transform into explicit knowledge, because tacit knowledge may interpret explicit knowledge to different individual, but tacit knowledge can only be transformed into explicit knowledge in certain conditions. So the channel of tacit knowledge transfer is very important. Transfer channel includes job training, face to face communication and chances faced at work, and so on. The key to tacit knowledge transfer is keep channel unblocked, communication of transferor and transferee are based on trust and friendship. Transferor and transferee can share a mutual vision in the future, and develop a knowledge-sharing culture. In the situation, blockage channel will be unblocked, and technology transfer will be more effective.

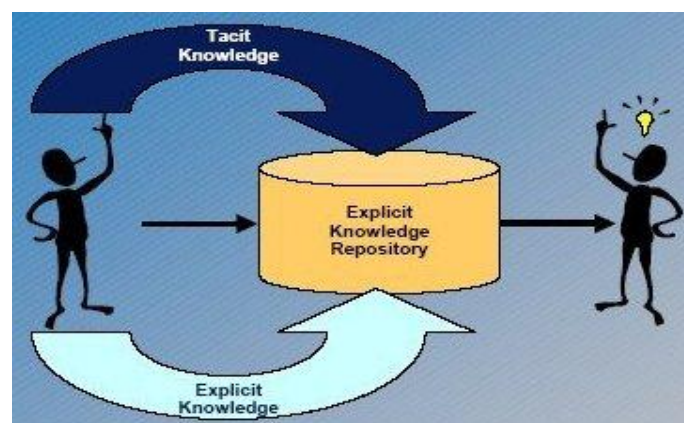


Figure 1. Knowledge transfer (Source: xinexus NUCLEAR AG)

Success of Knowledge Transfer

Berger (1998) pointed out the some necessary skills to develop successful knowledge transfer.

Communication, Knowledge transfer could take place informally or formally, requires both interest of transferor and transferee. Communication is the most elements in the knowledge transfer process. Effective communication skill in terms of knowledge

transfer will enable the good understanding and recognising of differences and promote mutual interests between sender and receiver, consequently an effective information exchange.

Behavioural expectation, Under his definition, behavioural expectation includes the awareness of proper behaviours at proper occasion, and tactful leading and negotiating managerial skill to cope in an appropriate manner, and recognise difference in decision making when in different culture background.

Culture Value, Knowing which cultural values are most likely to impact on business, for example, Leadership and decision-making style, importance of structure, individualistic, compared to collectivist style of relationships and the importance of time (Hofstede 1980). Hence the ability to adapt the culture differences is important.

Cross-culture Team Building, Knowledge transfer can be considered as a form of interaction, it could occur between individuals, partners, organisation and countries. Hence Learning networks are used to bring people together from different background to exchange practical ideas which may eventually result in innovative practices in companies (Kululanga, 1997). The ability to build cross-culture network could enhance this interaction, thus promote a successful knowledge transfer.

The Research, Design and Philosophical Notions

The literature review provides a wide and extensive understanding of international technology transfer, however, with a few exceptions that touch appropriateness and effectiveness of international technology transfer (Abbott,1985; Carrillo,1993,1994,1996; Bin, 1996,1997; Ofori, 1994 and Richard-LiHua, 2000, 2004, 2006), little has been done in the research area of technology transfer of coal mining industry, in particular, in China's coal mining industry.

Two concepts, internal and external validity, are fundamental and crucial to developing research designs. Ideally research design should be both internally and

externally valid. Therefore, the research project is composed of the Structured Survey and the interviews, and both of which are designed to be an integral part of the study. It has been recognised that the Structure Survey will certainly generate valuable results, which might be the causal conclusions. However, it is believed that the interviews of managers will generate result in a much wider context, which will sustain the external validity. In order to minimise discrepancies between the data collected during the study and the phenomenon of the real world, the current research project has adopted a mixed methodology that combines both qualitative and quantitative approaches.

Therefore, China's coal mining industry research problems addressed in this study:

- What is a core problem needs to be solved through technology transfer in current China's coal mining Industry?
- Is the current technology transfer is appropriate and effective in China's coal mining Industry?

Key Assumptions

The current study sets its boundaries within the context of the coal mining industry in China. Therefore, the structured survey was designed and arranged in China, In particular, the survey was undertaken in Henan Province, the statistic show that Ninety five percent of the country's coal reserves are located in Henan, Shanxi, Inner Mongolia, Xinjiang, Ningxia, Anhui, Yunnan, Shandong and Heilongjiang provinces (Zhong Ziran). Henan province is one of the largest coal production provinces with net output exceeding 10 Mt annually, as shown in Fig 2, having long history of coal exploit. There are total 6 large state-owned coal mines and more than 800 coal wells in this area. The coal production are not only satisfied the coal demand in Henan Province, but also supply to adjacent areas and export to overseas. Hence, the coal industry is the pillar industry in Henan Province.



Figure 2 the raw coal reserves in different provinces

Source: the State Coal Industry Bureau

Aims and Objectives of the Study

The study aimed to investigate the appropriateness and effectiveness of current technology transfer in China's coal mining industry with an aim to help to reduce gas explosion of coal mining industry in China, the result may help manager in making appropriate technology transfer arrangement for more insurance of a safety environment.

In particular the objectives of current research project are:

- From the literature, to establish a theoretical framework for the technology transfer in coal mining industry of China.
- To identify the appropriateness and effectiveness of technology transfer of coal mining industry of China
- To identify the major issue of technology transfer of coal mining industry of

China.

A Structure Survey in Henan Province

The State Coal Industry Bureau reports shows Henan province had very complex underground coal bed situation, coal mining exploitation is more difficult, the cost and the efficiency of coal production is also affected. Hence the local government had emphasized investment on the scientific research and development on mine design and construction, as well as mining machinery manufacture, to form a complete coal production system.

Moreover, the reformation is carried out successfully in Henan province. Under local jurisdiction, some enterprises in this province became the pioneer in the leading the coal company to achieve modernization in China and access stork market. The Pingdingshan Coal Co. Ltd. Group is one of the largest coal enterprises in this province, which has been ranked 175 among Chinese Top 500 Enterprises.

For the prosperous development of coal industry, the local government had broadened nationally and internationally, collaboration. However, it has successfully attracted both domestic and foreign big enterprise as partner, and established some joint venture projects, which made a distinct promotion on economic growth.

Interpretation and Analyses of the Survey Data

Respondents

With the help and support of the Coal Mine administration bureau in Henan Province and Coal Science Research Institute of Pingdingshan, we have got 60 questionnaires from respondents in Henan Province, these respondents were senior managers of coal mines of stated-owned and local-owned from province, city, county and town, many respondents were departmental managers and engineers of coal mines, some

respondents were the decision-makers of coal mines, such as presidents, director, general manager, deputy general managers and chief engineers.

The design of question is mainly focus on collection of views with regard to technology transfer in coal mining industry of China, appropriateness and effectiveness of technology transfer; lastly, general information of respondent is recorded to ensure objective and valid survey.

	Question that reflex the Main Themes
1	Could you please talk about the present safe situation of the coal mine industry in China
2	What do you think as a core problem needs to be solved through technology transfer in current coal mine industry?
3	Which country do you think you will choose to import technology from? And why?
4	What is the timetable when you think importing technology to solve the problem?
5	What are the ratios of investments in regard to international and domestic technology transfer and technology innovation on R&D?
6	In your opinion, in what means transferor and transferee could contractually achieve the technology transfer?
7	What do you think as major factors that influence the technology transfer process?
8	Is the current technology transfer is appropriate and effective in coal mining industry of China?
9	How to develop an appropriate and effective technology transfer?
10	Can you give some suggest or advice on the development of technology transfer in coal mine industry in China?

Survey Findings and Interpretation

The first question and second question are about identifying the core problem to be solve through technology transfer in coal mine industry, the view of respondents shown great tendency on gas explosion. 84 percent of the respondents believe that gas

explosion is a core problem to be solved urgently in coal mine industry through technology transfer. 16 percent of the respondents think systemic management mechanism is a core problem to be solved through technology transfer.

Question three is about choosing technological source, 47 percent of respondents prefer United States where gas exploration technology are state of art while, 45 percent of respondents believe that UK has effective and systemic coal mine management technology, only 8 percent of respondents are considering import technology from Germany and Australian.

Question four investigates the timescale of importing technology to solve the problem, 73 percent of respondents hope to resolve with immediate effect, 27 percent of respondents hope to at least achieve improvement in two or three years.

Question five investigates the enterprise investment ratios of technology innovation and transfer, the questionnaire is “what are the ratios of investments in regards to foreign and local technology transfer and technology innovation on R&D?” 59 percent of respondents insisted on major investment of independent R&D, 23 percent of respondent protest the investment on domestic technology transfer, and 18 percent of respondents thinking utilize of international technology transfer.

Question six and seven investigates the major factors that influence the contractually achievement and process. 55 percent of respondents think practical effect of technology transfer is major influential factors, 30 percent of respondents think expenses of technology transfer plays dominant part, and 55 percent of respondents think the technology gap of transferor and transferee as major consent.

Question eight and nine researched on how to use appropriate and effective transfer technology to solve safety problem of coal mining industry of China. 47 percent of respondents claimed that current technology transfer is not appropriate and effective, 48 percent of respondents stress on involving our own experts in contract negotiation of technology transfer, 46 percent of respondents hope to depend on intermediate

agent to accomplish technology transfer, at the same time, there are 55 percent of respondents need intermediate agent to supervise entire technology transfer process, moreover, 43 percent of respondents hope to focus on the service and know-how upon accomplished technology transfer.

About question ten, a majority of respondents think coal mining industry of China need new technology to improve safe issues, especially, gas explosion and exploitability. A majority of respondents hope to get effective technology with competitive costs.

Analysis and Discussion

Richard-LiHua (2006) points out that knowledge transfer is key to control technology transfer, knowledge transfer is crucial in the process of technology transfer, without knowledge transfer, technology transfer does not take place, tacit knowledge transfer is key of knowledge transfer. According to the data collected from interview, 84 percent of respondents think gas explosion is a core problem to be solved depends on technology transfer, 47 percent of manager thinks current technology transfer is not appropriate and effective. Technology transfer had taken placed in coal industry, but this equipment and technology has not emphasis on gas explosion and safe management which considered as the essential problem in coal industry.

Coal mines which in principle have a capacity of 300 thousand tons output annually have been classified as large state-owned, 81.5 percent of these enterprise have been operating with mechanization, with their capital and technological advantage, large state-owned coal mines will have better implementation of technology transfer, hence they possess good solutions to safety problems, gas explosion are well-controlled, consequently the mortality is much lower in those large coal mines. To obtain sustainable development, large coal mines should concentrate on technology gap remained in compare with international standard, and develop their own research towards technology innovation to solve the potential problem.

Coal mines which in principle have a capacity of 150 thousand tons coal production annually have been classified as small coal mines. Compare with large coal mines, small coal mine have limited funding and local support, inherently, small coal mine reduced the magnitude of mechanization, mine operation and management are also weak, they often violating regulations in operation in order to maximum production. There is little safety awareness in the small coal mines. And half of mineworkers are still illiterate or semiliterate.

Why violate operation exist within small coal mine, 47 percent of managers in the investigation thinks this problem is mainly due to the inadequate systemic supervision and management mechanism. Comparing with Britain, British Coal mining industry kept "zero" mortality over many year, this is not haphazard phenomenon, it rely on well-implemented systemic management mechanism. At the same time, strike chastisement rule is necessary, author think coal mining industry of China should learn advanced management technology in British in order to reduce mining accident. On the other hands, gas exploration technology in United States can help coal mine industry in China to reduce gas explosion, large state-owned coal mine will have superior to these technology transfer, with evaluation from their own technology experts and senior engineers, technology transfer will more appropriate and effective in those large enterprises. .

Author point that needs to be addressed is that small coal mine is not fit for international technology, LiHua (2004) point out if there is too big a gap in terms of economic development between transferor and transferee, technology transfer is not obtainable. International technology transfer in small coal mine development is not achievable. Therefore the better approach is to encourage technological collaboration between large state-owned coal mine and small coal mines.

At the same time, R&D in large state-owned coal mine has the ability to develop their core technology, for example: coal gasification technology, shoring protection

technology. Hence Large state-owned coal mine should aim at technology exporting to increase its financial profit.

Conclusion and Recommendations

Based upon the current research on coal mining enterprises of Henan province, we understand that some big coal mining enterprise in Henan province had well-developed, however small coal enterprise still remains problematic, especially on enforcement of mining safety protection. Large state-owned coal mine received more attention than small coal mines. In terms of technology transfer, the large coal mine should focus at international interaction to enhance the development globally. The illegal coal mine and small coal mines operations have highlight the necessity on strengthening managerial mechanism. The development of small coal mine should be stimulated by regional technology transfer, in both technological and managerial.

In China's rapid development environment, technology innovation and replacement are essential to stimulate the growing business and sustain competitive advantages. Coal in China is a major energy for power supply and household service, hence the coal industry and coal related production is coupled with civic and industrialization development closely. It is vital that the coal mining industry should pursue state of art technology and equipment. Chinese coal mining industry should be encouraged to implement the appreciate technology transfer to facilitate the coal mining industry grow toward international standard. It is too subtle to make this turn. However, Chinese coal mining industry should build its technology capacity through technology transfer. However, developing countries, such as China, has to understand explicitly that "real core technologies cannot be purchased but can only be achieved by developing 'indigenous innovation' ". Therefore there is a growing need to consolidate the technological capacity building and to develop the strategy of technological innovation.

When considering the small coal mine with limited resourced and development

capability, technology transfer through a proper channel or technology transfer platform can help small coal mine to seek not the most well developed technology but the most feasible technology innovation. Therefore digestion obtained technology in technology transfer process is major factors to the successful technology take over. Coal mining is huge industry, state-owned coal mine and small coal mine development remain unbalanced, technology transfer nationally and internationally are both exist, so we should consider various type of technology transfer mode, to effectively reduce state-owned coal mine and small coal mine development unbalance in order to reduce gas explosion accident.

Recommendations

In this research, coal mine industry in Henan province instead of whole China had studied, which to some extent sustains the internal validity. As for how well this discussion can represent coal industry in China still need further study in a much wider context.

Further development should be carried out in the following aspects:

To effectively link up the transferor and transferee and establish a common understanding on the technology transfer process, it is always important to consider the establishment a technology transfer platform. Refer to Triple Helix in China: Challenges. JTMC Volume 3, Special Issue, University in China as a government subsidiary have lots of advantage, science research level and technology innovation capability in university can be utilized as strong foundation, it owns more professional and systemic technology transfer operation knowledge and research technology transfer field expertise. These factors will enable university to develop more appropriate technology transfer means, provide more professional technology transfer advise, meanwhile inappropriately operation and inefficient technology transferred can be avoid. At the same time, the service provided by the transfer platform will help foreign group understand China local culture and environment, avoid failure due to

the localization, on the other hand, it will facilitate the understanding towards globalised development in the future. Therefore select the platform as the technology transfer channel is an appropriate and effective shortcut.

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