FROM TECHNOLOGY TRANSFER TO KNOWLEDGE TRANSFER-A STUDY OF INTERNATIONAL JOINT VENTURE PROJECTS IN CHINA

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Abstract
Technology transfer has been a subject of considerable interest to many groups, such as government policymakers, international funding agencies, and business executives, because of the close relationship between technology transfer and economic growth. It has aroused the interest of academic researchers. Despite all this attention, however, the concept and mechanism of technology transfer remains vague, controversial, and inadequately operationalised. This paper addresses the appropriateness and effectiveness of technology transfer. The study had identified that without knowledge transfer, technology transfer does not take place, as knowledge is the key to control technology as a whole. Hence, knowledge transfer is crucial in the process of technology transfer.

This paper describes a structured survey undertaken in Jiangsu Province, Henan Province and Xinjiang Autonomous Region, P.R.China, which examines a particular aspect of technology transfer within Sino-foreign joint ventures. The findings suggested important implications for the relationship between technology transfer and economic development. Technology transfer is not obtainable if there is too big a gap in terms of economic development between transferor and transferee. Moreover, knowledge transfer itself has a number of components, of which it is argued that explicit knowledge and tacit knowledge transfer are the most significant. Nevertheless, tacit knowledge transfer is considerably more haphazard and it is in this area that knowledge transfer can falter and technology transfer can be impeded. This study suggests means by which tacit knowledge transfer could be improved. In addition, it also leads the way for the introduction of systematic processes that could be specifically incorporated into World Bank projects that involve international technology transfer as a major feature.

Key words: China, joint venture, technology transfer, tacit knowledge, human interaction.

Introduction

Technology transfer is a crucial and dynamic factor in social and economic development. Technology has been transferred intentionally or unintentionally. Sometimes, a generator of technology has acquired a competitive advantage by undertaking the dissemination of products, processes and maintenance systems (Bradbury, 1978). Sometimes, a recipient (or transferee) has done much better than the original innovator. For example, it was the Chinese who invented gunpowder, but

the Europeans who used it and developed it for world conquest. Sometimes the technology has taken a new form at each transfer, absorbing local traditions of design or local market preferences and there is value added during the process of technology transfer.

The two words “technology transfer” seem to convey different meanings to different people and different organisations. Technology transfer is defined in the Work Regulations of the United Nations, as the transfer of systematic knowledge for the manufacture of a product or provision of service (Yu, 1991). It has been defined in many other ways. According to Abbott, (1985), it is the movement of science and technology from one group to another, such movement involving their use. Traditionally, technology transfer was conceptualised as the transfer of hardware objects, but today also often involves information (e.g., a computer software program or a new idea) that may be completely devoid of any hardware aspects.

From Technology Transfer to Knowledge Transfer

Research into technology transfer has matured from the early period of emphasis on the technology itself, through general management objectives to the current state of development where interest has arisen in the appropriateness and effectiveness of the technology transfer. It has been identified that without knowledge transfer, technology transfer does not take place as knowledge is the key to control technology as a whole. Knowledge transfer is crucial in the process of technology transfer. Therefore, the focus of the paper is to address the fundamental element of technology transfer – *knowledge transfer.*

Knowledge Transfer

Knowledge transfer is about connection not collection, and that connection ultimately depends on choice made by individuals (Dougherty, 1999). It is worth noting that this form of transfer in particular may well be a ‘two-way process’ between the transferor and the transferee. Knowledge transfer is also an increasingly popular term in the literature as writers attempt to highlight the human aspect of knowledge management.

This natural transfer, or unstructured exchanges and informal exchanges, are vital to a firm's success. It is of great significance for an organisation to be able to capture and use the knowledge inside managers' heads. 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 organisational learning.

Explicit Knowledge and Tacit Knowledge

Polanyi (1967) considered human knowledge by 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" at its most literal sense. In general, knowledge consists of two significant components, namely explicit and tacit. However, the greater the extent to which a technology exists in the form of the softer, less physical resources, the greater the

proportion of tacit knowledge it contains. Tacit knowledge, due to its non-codifiable nature has to be transferred through 'intimate human interactions' (Tsang, 1997).

Research Concept Design and Philosophical Notions

The literature review provides a wide and extensive understanding of international technology transfer. However, with a few exceptions that touch international technology transfer (Abbott, 1985; Carrillo, 1993,1994,1996; Bon, 1996, 1997; and Ofori, 1994), little has been done in the research area of knowledge transfer, in particular, tacit knowledge transfer. However, it has been clear that the subsequent literature review (Tsang, 1995, *et al*.; Maitland, 1999; Holland, 1999; and Egbu, 2000, *et al*.) of knowledge transfer in terms of explicit knowledge and tacit knowledge has made the research aims more focused. Hence, the research problems addressed in this study, are:

- *Is technology transfer appropriately and effectively channelled?*
- *What is the relationship between technology transfer and economic growth?*

Key Assumptions

The current study sets its boundaries within the context of the construction industry in China. Therefore, the structured survey was designed and arranged in China. In particular, the survey was undertaken in three different regions in terms of economic development in China. The unit of analysis of the study was various 'dyads' or management pairs with one foreign element and one local element, and whose roles demand that they work together (refer to figure 1.). In fact these dyads are numerous, and made up of foreign-foreign (F-F), foreign-local (F-L), local-local (L-L) but for the immediate purposes of the current research, only the foreign-local (F-L) dyads are of interest. Figure 1 represents the work patterns of dyadic interaction.

Pattern 1 Foreign-Foreign
Pattern 2 Local-Local
Pattern 3 Foreign-Local

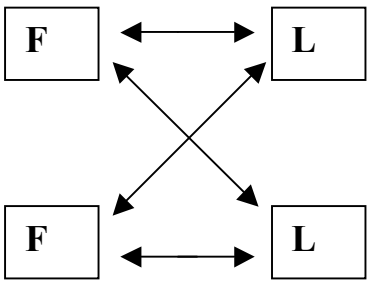

Figure 1. Work patterns of dyadic interaction (Li-Hua and Greenwood, 2000)

Problem Area: from Technology Transfer to Knowledge Transfer

Mnaas (1990) states that technology consists of four closely inter-linked elements: namely, technique, knowledge, organisation and product. However, knowledge contributes the major part to technology, which is the key to control over technology as a whole. It is important that the understanding of explicit and tacit elements of knowledge will help identify the process of knowledge transfer. With regarding to the appropriateness and effectiveness of technology transfer, Samli (1985) models the pattern of technology transfer with consideration of six dimensions: geography, culture, economy, business, people and government. In addressing knowledge transfer

issues in construction, Egbu (2000) develops a framework for managing knowledge, where he emphasises five dimensions, such as, people, content, culture, process, infrastructure and technology. It should be noted that the above research work has provided wider understanding and significant insights towards the building an effective and applicable model of knowledge transfer. However, a framework for the establishment of effective knowledge transfer shown as figure 2 has been developed based upon the major contribution of the above research works. It should be pointed out that this framework combines both technology transfer and knowledge transfer, where the importance of tacit knowledge transfer has been established and the blockage of tacit knowledge transfer has been raised.

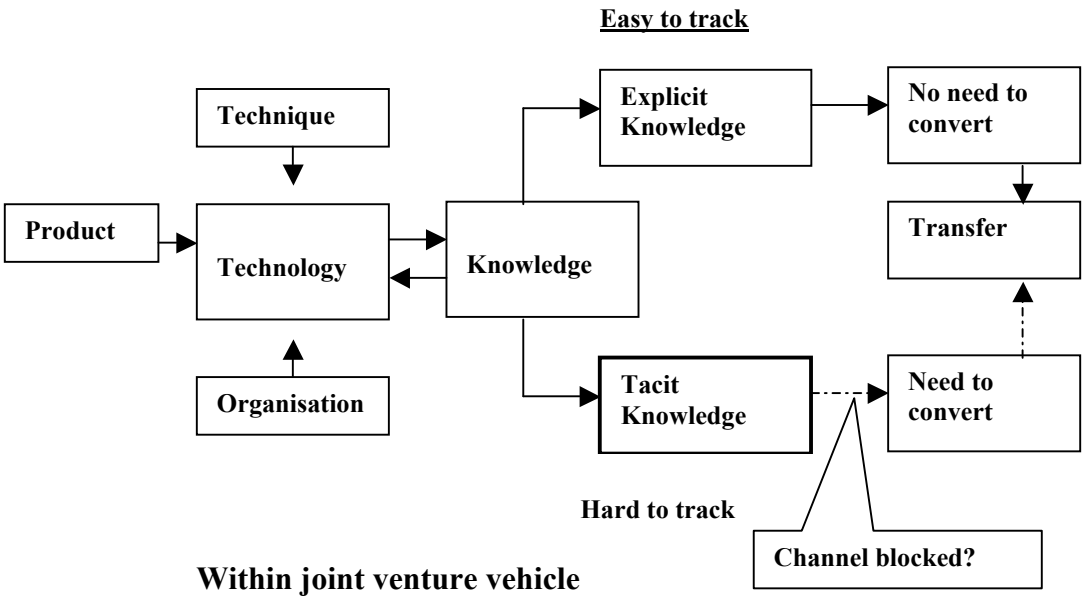

Figure 2. A framework for effective knowledge transfer

Aims and Objectives of the Study

The study aimed to investigate the current mechanisms of technology transfer and aspects of technology transfer between foreign and local managers within international joint ventures in China. The results may ultimately assist in assessing the efficacy of technology transfer and may inform decision-makers in the recipient and donor organisations as well as investors such as the World Bank, who impose contractual provisions that require technology transfer.

In particular the objectives of the current research project are:

- From the literature, to establish a theoretical framework for the tracking of the technology transfer process;
- To evaluate the appropriateness and effectiveness of the study by a structured survey;
- To identify the implications of the relationship between technology transfer and economic development levels.

A Structured Survey in Jiangsu, Henan and Xinjiang

A literature review shows that there is no academic work that examines the current situation of the economic development of the provinces and autonomous regions in PRC. However, Table 1 was established based on the Construction Statistical Yearbook of China, 1998, which shows the current positions of Henan, Jiangsu and Xinjiang ranked by gross output value (GOV) of construction in the country. It is hoped that the construction activities in these regions will reflect the different levels of economic development in the construction industries in China.

Table 1. League Table of Provinces, Municipalities (directly under the Central Authorities) and Autonomous Regions in China by Gross Output Value of Construction

	Name	Capital City	GOV in RMB 1998
1	Jiangsu	Nanjing	10,716,094
2	**Zhejiang**	**Hangzhou**	**8,773,546**
3	Guangdong	Guangzhou	6,747,406
4	Shandong	Jinnan	6,479,717
5	Shanghai	Shanghai	5,524,161
6	Sichuan	Chengdu	5,206,436
7	Beijing	Beijing	5,192,363
8	Liaoning	Shenyang	4,291,256
9	Hebei	Shijiazhuang	3,760,962
10	Hubei	Wuhan	3,059,698
11	Hunan	Changsha	2,965,005
12	**Henan**	**Zhengzhou**	**2,946,903**
13	Chongqing	Chongqing	2,440,552
14	Heilonhjiang	Harbin	2,435,310
15	Anhui	Hefei	2,359,972
16	Fujian	Fuzhou	2,268,855
17	Yunnan	Kunming	2,189,844
18	Shanxi	Taiyuan	1,920,095
19	Tianjin	Tianjin	1,909,999
20	Shaanxi	Xi'an	1,642,493
21	Jilin	Changchun	1,369,882
22	Guangxi	Nanning	1,275,627
23	**Xinjiang**	**Urumqi**	**1,141,318**
24	Gansu	Lanzhou	1,056,249
25	Neimonggou	Huhhot	963,852
26	Jiangxi	Nanchang	856,436
27	Guizhou	Guiyang	767,046
28	Ningxia	Yinchuan	334,919
29	Qinghai	Xining	309,340
30	Hainan	Haikou	279,923
31	Xizhang	Lhasa	79,519

Table 1. League Table of Provinces and Regions in PRC

Jiangsu Province

The economy in Jiangsu Province has grown steadily and quickly since the economic reform starting from 1978. Jiangsu, with a population of 71 million and an area of 102,600 square kilometres, is making the most of its productive location in the Yangtze River Delta. A chief economic indicator in one of China's most developed provinces, Jiangsu's GDP reached RMB335.8 billion (US$48.5 billion), 10% increase over the same period of the previous year. Jiangsu is the birthplace of many of China's most important national industries. For years the value of its industrial output has ranked first in the country.

Henan Province

Located in the central and eastern part of China, at the middle and lower reaches of the Yellow River, Henan Province has an area of 167,000 square kilometres and a population of 88.61 million. It was the birthplace of the Yellow River Culture. According to a large number of popular legends and historic records, it was here that Fuxi, Nuwa, Xuanyuan Huangdi, Diku, Zhuanxu, the ancestors of the Chinese nation, created Chinese civilization. The Yellow River basin has been called the cradle of the Chinese nation where mankind lived as early as 500,000 to 600,000 years ago. In Henan Province several hundred cultural sites of the Neolithic Age (4,000 to 10,000 years ago) have been found. The famous Peiligang, Yangshao, and Longshan Cultures reflect the prosperity in this area during the late period of primitive society. From the period of 21st century B. C., when the Xia Dynasty, the first dynasty in China's history, was established, to the Northern Song Dynasty, more than 20 dynasties with more than 200 emperors set or moved their capital cities here.

Xinjiang Autonomous Region

Xinjiang has a population of 17.18 million. Situated in Northwest China and in the centre of the Eurasian continent, it is over 1,600,000 square kilometres in area, making up one-sixth of the entire territory of China, the biggest of all the country's provinces and autonomous regions. Xinjiang's economy presents a good situation of "high increase and low inflation". However, the basis for further economic development is not stable yet; the pace of structural adjustment is still slow; the production management of state-owned enterprises is difficult; and the overall situation of the economy is still not ideal. From 1949, ethnic Han emigration to Xinjiang rose and fell with events in eastern China. The great majority of the emigrants to Xinjiang in 1990 [88 percent] came from rural China but were in general better educated than the average Xinjiang resident. Xinjiang will pay more attention to the ecological environmental construction and attach equal importance to environment protection and pollution control.

Given the background of Jiangsu Province, Henan Province and Xinjiang Autonomous Region, based on the comprehensive comparison of the economic indicators of construction industry in these regions, the conclusion will be that these economic indicators in these regions mirror clearly their different development levels in construction activity. Jiangsu Province is well-developed, Henan Province is newly-developed and Xinjing Autonomous Region is less-developed. In addition, Jiangsu Province has the feature of strong industry, Henan Province has a long history and a rich culture, while Xinjiang Autonomous Region has a feature of immigrants with a large potential to develop. In the next section, the discussion will focus on the

discussion of the implication of these economic indicators and how they give impact to the process of knowledge transfer.

Implementation of the Survey in Jiangsu, Henan and Xinjiang

In the Survey, copies of a refined assessment inventory were delivered by the researcher and distributed by the construction authorities in the three chosen regions, Jiangsu Province, Henan Province and Xinjiang Autonomous Region. These three locations have been chosen because they represent different economic development levels of the construction industry in China. Appropriate consideration of these factors will contribute to the understanding of the data collected and the information obtained. The study focuses on how knowledge (in particular tacit knowledge) was transferred between foreign and local managers when they completed a construction task – method statement. It is believed that the transfer of knowledge when dealing with method statements will mirror the process of problem-solving and decision-making as well as the process of knowledge transfer in the whole industry.

Design Rational and the Main Themes of the Assessment Inventory

As has been established previously, the focus of the Study was to identify the process of knowledge transfer through the intimate human interaction between foreign and local managers in the joint venture organisation. The objective of the study was to obtain practical and useful quantitative and qualitative data through the survey. Against this background, with a consideration of pattern-matching and explanation-building when having quantitative analysis, a design of the Assessment Inventory of the Study was carried out with in particular the following objectives and issues being highlighted in Table 2.

Interpretation and Analyses of the Survey Data

Respondents

With the help and support of the Construction Management Bureaux of Jiangsu Province, Henan Province and Xinjiang Autonomous Region, PRC, the copies of assessment inventories were distributed among joint venture companies and construction enterprises in the three regions in China. There were four hundred fifty (450) respondents from the three regions. These respondents were key personnel from within Sino-foreign joint venture companies and large-middle sized construction enterprises, who were departmental managers and engineers of the companies. Some respondents were the decision-makers of the enterprises, such as presidents, general managers, deputy general managers, chief engineers, and chief economists of joint venture companies and construction enterprises.

	Main Themes	Questions that reflex the Main Themes
1	Why a method statement is needed	Question 1 tries to explore various reasons why a method statement is needed.
2	Form of method statement	Question 2 tries to identify the form of a method statement.
3	Background to a method statement	Question 3 tries to identify the background knowledge of a method statement.
4	Further reasons for using a method statement	Question 4 tries to identify further reasons for using a method statement.
5	Authority over a method statement	Question 5 tries to identify which party has the authority to control a method statement while Question 6 tries to identify the people who are mainly involved in the process of discussing a method statement.
6	What knowledge is being transferred	Question 7 and 9 try to identify what knowledge is needed between foreign and local managers in terms of construction technology (hard knowledge or explicit knowledge) and management know-how (or soft knowledge or tacit knowledge), whereas Question 8 and 10 try to identify what knowledge were actually transferred in terms of hard knowledge and soft knowledge.
7	How knowledge transfer takes place	Question 11 and 12 try to identify the different channels of explicit and tacit knowledge transfer while Question 13 tries to identify the pattern of knowledge transfer.
8	Success of knowledge transfer	Question 14 tries to identify the influence factors of knowledge transfer, while Question 15 and Question 16 try to identify the factors in achieving a successful knowledge transfer and the motivators of knowledge transfer.
9	Critical and key issues	Question 17 tries to identify the critical and key issues of knowledge transfer in the process of construction.
10	Consequence of knowledge transfer	Question 18, 19 and 20 try to identify the aftermath of the knowledge transfer.

Table 2. Main Themes of the Assessment Inventory

It should be noted that consultants to the World Bank and to the Chinese Government who are working at the Xiaolangdi [1]Project are also among the respondents. Table 3 shows the location and the whole sample of respondents in the Study.

Regions in PRC	Chinese respondents	Foreign respondents	Total in regions	Total in the Study 450
Xioalangdi	52	9	61	61
Jiangsu Province	161	-[2]	161	161
Henan Province:	128	-	128	128
Xinjiang Autonomous Region	100	-	100	100

Table 3. Location and whole sample of the respondents in the Study

[1] A Pilot Study of the current research project was carried out at the Xiaolangdi Project, which was quoted as a demanstration project of international project management. The result of the Pilot Study had been presented at Sixteenth Annual Conference, 2000, September 6-8 at Glasgow Caleedonian University, the UK.

[2] It has been confirmed by the construction authority of the three regions that there were efforts made to involve both foreign and local managers. However, it appears that there are no foreign respondents.

Exploring the Correlation between Knowledge Transfer and Economic Development

Previously, the three geographical sources of data for the Main Study were discussed. Further, in the case of responses from Henan, a differentiation was made between those returned from the Xiaolangdi Project and 'others'. This was considered to be advisable, owing to the size and potential influence of the Xiaolangdi Project itself, and its potential for skewing the general response from Henan Province. It was considered to be potentially informative to explore the relationships between aspects of knowledge transfer and the level of economic development of each of the three geographical sources of data. To enable a more detailed analysis of the relationship between knowledge transfer and economic development, a correlation analysis was carried out with the economic indicators and the data derived from the three sample places, the measure of association adopted was Pearson's r. In order to do this, the first step was to construct a notional but valid scale of economic development. The basis of this scale was the economic data presented previously, in particular the ten indicators of economic development obtained from Construction Statistical Yearbook of China.

1. *Creation of a notional scale of economic development.* The ten indicators of economic development in construction in question are shown in Table 4.

1. Gross output value of construction (10000 yuan)
2. Number of projects (projects)
3. Construction quality projects (projects)
4. Statistics on machinery and equipment (pieces)
5. Value added of construction (10000 yuan)
6. Total floor space completed (10000 sqare metre)
7. Total capital and structure of total assets (10000 yuan)
8. Liabilities and creditors' equity (10000 yuan)
9. Total profit (10000 yuan)
10. Total number of construction enterprises (companies)

Table 4. Indicators of economic development

In each case, the results for Jiangsu, Henan and Xinjiang were computed as percentages of the national total figure. The resulting percentages were treated as relative development scores for each of the ten indicators, and on that basis were added to give an aggregate development score for each.

	Jiangsu	**Henan**	**Xinjiang**
1. Gross output value of construction	0.1174	0.0323	0.0125
2. Number of projects	0.0941	0.0438	0.0175
3. Construction quality projects	0.1110	0.0502	0.0129
4. Machinery and equipment	0.1001	0.0436	0.0115
5. Construction added value	0.1032	0.0313	0.0136
6. Floor space completed	0.1224	0.0387	0.0109
7. Total assets (10000 yuan)	0.0887	0.0261	0.0138
8. Investors' equity	0.1041	0.0241	0.0129
9. Total profit	0.1033	0.0237	-0.0040
10. Construction enterprises	0.0724	0.0448	0.0147
Aggregate score	1.0168	0.3586	0.1163

Table 5. Economic development scores for the three geographical data sources

For simplicity in graphical scaling, the data were then simply transformed into a 'normalised' index, with Jiangsu (raw score 1.0168) being treated as 100. This resulted in the following 'development index' for the three regions in question:

Jiangsu	Henan	Xinjiang
100	35.27	11.44

Table 6. Notional development index for the three geographical data sources

Correlation of Study Data with Notional Scores of Economic Development. Next, these newly created notional economic development indices for the geographical sources of data were tested for association with 19 of the 20[3] sets of responses from the survey. For the purpose, the CORREL function in Excel was used. This function (in common with most similar statistical routines) produces a value for Pearson's *product moment correlation coefficient*, *r*. This coefficient takes values from +1 to -1 and is given by

$$r = \frac{\sum (x_i - \bar{x})(y_i - \bar{y})}{(n-1)\, s_x\, s_y}$$

where $\sum x_i$ = sum of the variable x of all the n measurements, and
$\sum y_i$ = sum of the variable y of all the n measurements
s_x = standard deviation of x
s_y = standard deviation of y

The sign (+ or -) indicates the *direction* of the relationship (positive or negative), and the number indicates the strength of the relationship. In the following analysis, values less than 0.3 have been described as 'weak'; between 0.3 and 0.5 as 'moderate'; 0.5 and 0.6 as significant, and 0.7 and above as 'strong'. The results of the correlation are shown in Table 7.

		Jiangsu	**Henan**	**Xinjiang**	Pearson ‘s r	**Comment**
How did you communicate method statement?	Formal document	65.64%	42.61%	41.58%	0.975	Strong +ve
	Sketch or note	19.63%	56.52%	32.67%	-0.578	Significant -ve
	Verbal	14.72%	0.87%	25.74%	-0.196	Weak -ve
Form of method statement	Handbook	22.44%	14.81%	9.00%	0.983	Strong +ve
	Previous MS	16.67%	16.10%	25.00%	-0.667	Significant -ve
	Contract document	55.77%	53.00%	45.00%	0.861	Strong +ve
	Handmade	5.13%	16.10%	21.00%	-0.999	Strong -ve
Main reason	Task Complex	18.52%	3.74%	4.00%	0.961	Strong +ve
	Resources	36.42%	33.64%	51.00%	-0.595	Significant-ve
	Work guidance	25.93%	11.21%	17.00%	0.788	Strong +ve
	Required by client	19.14%	51.40%	28.00%	-0.505	Significant -ve
Which party had the final say	Local	16.97%	4.58%	22.00%	-0.024	Weak -ve
	Foreign	24.85%	3.05%	30.00%	0.079	Weak +ve

[3] Question 1 of the inventory survey was an open question and no quantitative data resulted.

say	Together	58.18%	58.00%	48.00%	0.719	Strong +ve
Which party was mainly involved	Local	7.83%	30.75%	13.27%	-0.470	Moderate -ve
	Foreign	16.87%	12.25%	30.61%	-0.516	Significant -ve
	Together	75.30%	57.00%	56.12%	0.975	Strong +ve
Main needed knowledge	Cnstr. technology	16.56%	15.79%	30.69%	-0.675	Significant -ve
	Mgnt know-how	83.44%	84.21%	69.31%	0.675	Significant +ve
Main actual knowledge	Cnstr. technology	33.12%	33.70%	31.31%	0.524	Moderate +ve
	Mngt know-how	66.88%	66.30%	68.69%	-0.524	Moderate -ve
Main needed knowledge	Explicit	33.77%	68.22%	50.98%	-0.706	Strong -ve
	Tacit	66.23%	31.78%	49.02%	0.706	Strong +ve
Main actual knowledge	Explicit	48.08%	51.64%	46.32%	0.071	Weak +ve
	Tacit	51.92%	48.36%	53.68%	-0.070	Weak -ve
Main channel (explicit knowledge)	Conferences	29.80%	20.18%	30.61%	0.190	Weak +ve
	Meetings	30.46%	53.51%	13.27%	0.178	Weak +ve
	Seminars	27.81%	14.04%	50.00%	-0.387	Moderate -ve
	Training	11.92%	12.28%	6.12%	0.670	Significant +ve
Main channel (tacit knowledge)	Job training	17.86%	40.00%	12.12%	-0.064	Weak -ve
	Telephone	22.14%	19.23%	22.22%	0.235	Weak +ve
	Social	39.29%	20.51%	53.54%	-0.183	Weak -ve
	Chance meeting	20.71%	20.26%	12.12%	0.740	Strong +ve
Principal pattern of transfer	Foreign - local	28.66%	53.85%	28.28%	-0.245	Weak -ve
	Local - foreign	14.63%	7.69%	33.33%	-0.498	Moderate -ve
	2- way process	56.71%	38.46%	38.38%	0.967	Strong +ve
Main influencing factor	Culture	9.93%	13.33%	32.32%	-0.800	Strong -ve
	Language	30.46%	75.83%	25.25%	-0.166	Weak -ve
	Common objective	36.42%	5.00%	14.14%	0.853	Strong +ve
	Social values	23.18%	5.83%	28.28%	0.042	Weak +ve
Primary success factor	Mutual respect	18.13%	35.65%	35.42%	-0.962	Strong -ve
	Co-operation	60.63%	46.96%	48.96%	0.921	Strong +ve
	Co-ordination	21.25%	17.39%	15.63%	0.999	Strong +ve
Principal motivator	Mutual benefit	44.74%	24.37%	40.00%	0.466	Moderate +ve
	Collaboration	41.45%	24.37%	36.15%	0.538	Significant +ve
	Complete task	13.82%	51.26%	23.85%	-0.499	Moderate -ve
Principal issue resolved	Time	11.69%	2.88%	5.05%	0.877	Strong +ve
	Cost	22.08%	17.31%	23.23%	0.076	Weak +ve
	Safety	28.57%	36.54%	35.35%	-0.921	Strong -ve
	Quality	37.66%	43.27%	36.36%	-0.083	Weak -ve
Action with method statement after	Implemented	13.33%	17.05%	21.00%	-0.962	Strong -ve
	Revised	83.64%	61.24%	69.00%	0.819	Strong +ve
	Rejected	3.03%	21.71%	10.00%	-0.596	Significant-ve
If revised or rejected how resolved	By the local	18.29%	10.75%	12.63%	0.875	Strong +ve
	By foreigner	15.24%	14.55%	28.42%	-0.676	Significant -ve
	Compromise	61.59%	55.00%	48.42%	0.966	Strong +ve
	By third party	4.88%	19.70%	10.53%	-0.603	Significant -ve

Work carried out…	Normally	29.88%	34.88%	29.00%	-0.122	Weak -ve
	Better	70.12%	65.12%	71.00%	0.122	Weak +ve

Table 7. The correlation between knowledge transfer and economic development in Jiangsu, Henan and Xinjiang, PRC

There follows a step by step interpretation and analysis of the findings. Table 7. indicates a number of correlation between aspects of knowledge transfer and economic development in Jiangsu, Henan and Xinjiang. According to the correlation results shown in Table 7, the relationship between certain aspects of knowledge transfer and economic development can be predicated.

Survey Findings

What is the relationship between knowledge transfer and economic development? Are they positively or negatively related, or is the relationship more complicated? Based on the data obtained from the Study, this section will consider these questions.

Relationship between Knowledge Transfer and Economic Development

The study of construction activities with a comparison of the economic indicators among Jiangsu, Henan and Xinjiang suggests a notional hierarchy of economic development. Jiangsu is at the higher level with Xinjiang at the lower level, and Henan is in the middle position. Analysis and comparison of the data collected from the three regions suggests that certain aspects of knowledge transfer is paralleled by the notional line of economic development. In other words, there are features of knowledge transfer that appear to be associated with levels of economic development. To put it differently, this relationship between knowledge transfer and economic development is positively effected. Figure 3 represents a simplified view of the relationship between knowledge transfer and economic growth. The arrow in the figure indicates that the demand for knowledge transfer grows as the economy increases.

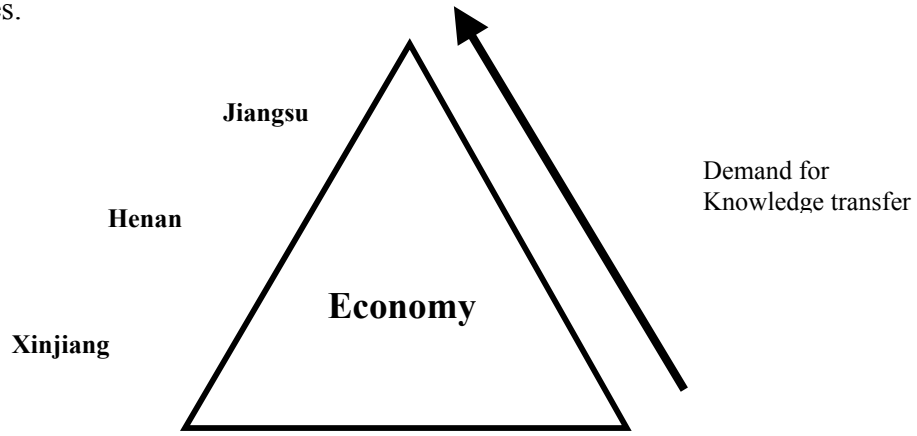

Figure 3. Relationship (notional hypotheses) between knowledge transfer and economic growth

Relationship between Transfer of Explicit Knowledge and Tacit Knowledge

A comparison based on economic indicators of the three regions suggests that in the well-developed region there is more demand for tacit knowledge transfer, while there is more demand for explicit knowledge transfer in the less developed region. In other

words, people in the well-developed economies are keen to obtain tacit knowledge (soft knowledge), such as management know-how, while people in the least developed economies are keen to obtain explicit knowledge (hard technology), such as a specific technology to manufacture a product. Thus, the relationship between the need for tacit knowledge transfer and explicit knowledge transfer is X – Shaped. This is shown diagrammatically in Figure 4.

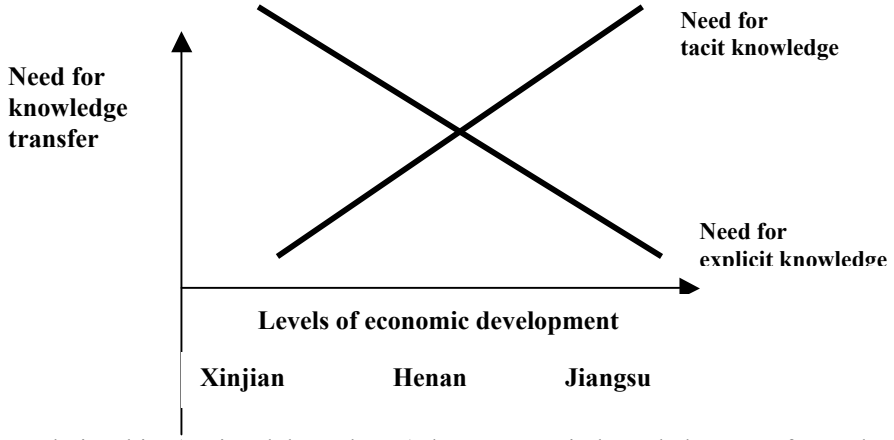

Figure 4. Relationship (notional hypotheses) between tacit knowledge transfer and explicit knowledge transfer

Based on the above, it is concluded that the desire to obtain more tacit knowledge increases and the desire to obtain more explicit knowledge decreases with the levels of economic development. In other words, in a developing economy, people are more thirsty for explicit or hard knowledge, such as a specific technology to manufacture a product that enables people to survive than for tacit or soft knowledge, such as management know-how that enables an economy to have sustainable growth.

Conclusion and Implication for Policy

Because of the inability to meet the demands of economic growth from current indigenous resources, the Chinese construction industry relies on foreign investment in its various forms. This is a short-term measure, but in the long-term China seeks the additional benefit of sustainable technology transfer. There are various modes of international activity that could have an effect. Of these, international joint ventures appear to be the preferred vehicle for both the recipients in question - China - and of its major external funder of construction activity - the World Bank.

The World Bank's policy in principle was that organisations should not be awarded contracts without forming meaningful partnerships with local companies and committing technology transfer. The World Bank has itself already recognised the difficulties in monitoring such a policy. Yet this deficiency results from the belief that there is something inherent in the technology that determines the effectiveness of transfer. This research supports the view that the nature of the technology is not a major factor. In fact, it appears that there is a pronounced effect in the relationship between the type of knowledge required and the technical development of the recipients. An important contribution of this research to the efficiency of the Chinese construction industry has been to analyse the components of knowledge transfer and determine how and why it is being inhibited. The tracking of *Method Statements*

showed that in general, explicit knowledge is being readily transferred. However, it is the tacit knowledge that has been neglected. To improve its delivery, this study points out that a more systematic approach is required for tacit knowledge transfer.

Implications for Policy and Practice

It has been identified that knowledge transfer is positively effected by the levels of economic development of the recipients. Given the situation that joint venture is a preferred vehicle for technology transfer to China, it is reasonable to suggest that it would be wise and practical to promote the establishment of joint ventures between Xinjiang and Jiangsu, or between Xinjiang and Henan rather than to promote setting up joint ventures between, for example, Xinjiang and the western countries. Knowledge transfer is not obtainable if there is a too big gap in terms of economic development between transfer and transferee, despite the governments and funding agencies promote technology transfer. It appears that there are 20,500 Sino-foreign joint ventures in Jiangsu and 2000 Sino-foreign joint ventures in Henan, which are operating effectively and efficiently, while statistics show that there were Sino-foreign joint ventures in Xinjiang till 1998. Of course it has been recognised in the study that the joint ventures between Jiangsu, Henan and the West countries are effective approach for transferring technology and developing the economy.

Reference

Abbott, P.G.,1985, *Technology Transfer in the Construction Industry 'Infrastructure and Industrial development. Special Report No.223 The Economist Intelligence Unit* The Economist Publications Ltd

Bon, R., 1997, *The Future of International Construction.* Building Research and Information p139

Bon, R., 1996, *Whither Global Construction? Some Results of the ECERU opinion survey 1993-1995* Building Research and Information Volume 24 No.2 p6

Bradbury, F.R., 1978, *Technology Transfer Practice of International Firms.* Netherlands: Sijthoff & Noordhoff International Publishers BV

Carillo, P., 1996, *Technology Transfer on Joint-venture Projects in Developing Countries*. Construction Management and Economics 14(1) January pp45-54

Dougherty, V., 1999, *Industrial and Commercial Training*, Volume 31. Number 7. 1999 pp 262-266 MCB University Press. ISSN 1019-7858

Egbu, C., 2000, *Knowledge Management in Construction SMEs: Coping with the Issues of Structure, Culture, Commitment and Motivation*. Proceedings of the Sixteenth Annual Conference of association of Researcher in ConstructionManagement (ARCOM), Glasgow Caledonian University, September 6-8 2000

Holland, D., 1999, *Ten Ways to Embed Knowledge Management into Organisational Culture*. Knowledge Management review. Issues 7

Leonard-Barton, D., 1995, *Wellsprings of Knowledge: Building and Sustaining the resources of Innovation.* Harvard University Press

Li-Hua, R., and Greenwood, 2000, *Technology Transfer in International Joint Ventures in China* Glasgow Caledonian University ARCOM Conference Proceedings

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

Mnaas, C., 1990, *Technology Transfer in the Developing Countries.*

London: The Macmillan Press Ltd.
Maitland, A., 1999, *Management Knowledge Management: Lessons can be learned from failed attempts to capture and use employees' knowledge* Management and Technology. The Financial Times
Ofori, G., 1994, *Construction Industry Development: Role of Technology Transfer*. Construction Management and Economics 12(5) pp379-392
Polanyi, M., 1967, *The Tacit Dimension.* Routledge & Kegan Paul Ltd, London
Samli, A., 1985, *Technology Transfer: Geographic, Economic, Cultural and Technical Dimensions.* Greenwood Press, USA.
Tsang, E.W.K., 1995, *The Implementation of Technology Transfer in Sino-foreign Joint Ventures*. International Journal of Technology Management, 10,7/8, pp757-766
Yu, X.Y., 1990, *International Economic Law.* Nanjing: University Press
Zhang, M. Q., 1987, *International Technology Trade.* Beijing: Foreign Trade and Education Press