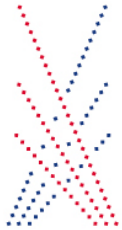

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Developing IJV's Absorptive Capacity for Promoting Low Carbon Technology Transfer: The Role of Intermediaries and External Channels

Track 10: International Business and International Management

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Abstract: One of the perquisites of a successful technology transfer is that the firm should have sufficient absorptive capacity. Such capacity is not a take-for-granted product but go through a sophisticated development process. While most studies highlight the absorptive capacity and network in the process, the role of intermediaries is often underlined. In this study, we adopt the process-perspective on examine how IJVs conduct external knowledge search via intermediaries in the absorptive capacity development process in IJVs technology transfer. Based on three in-depth qualitative cases in low carbon industry, this study unfolds that successful innovators should not be isolated from intermediaries in the recent model of the innovation system. Instead, they interact with a variety of intermediaries at different stages of technology/knowledge transfer to secure the best-available resources and knowledge supporting absorptive capacity-building and innovation, which finally becomes a part of their market competitiveness.

Keywords: technology transfer, international joint ventures, intermediaries, innovation, low carbon technology.

1. Introduction

Companies are increasingly relying on knowledge beyond their strategic alliance to support innovation (Chesbrough, 2017; Enkel et al., 2009; West et al., 2014) and have been developing relevant knowledge search strategies to access such resources and capabilities (Ferreras-Méndez et al., 2015; Laursen and Salter, 2006, Mina et al., 2014). As there is no firm could possess all technological elements or knowledge internally (Enkel et al., 2009; Mina et al., 2014), firms need to develop external links to access technology, knowledge or experiences from the outside sources and institutions, which could ease the process of learning, absorption and innovation(Cassiman and Veugelers, 2006; Laursen and Salter, 2006; West et al., 2014). They usually interact with a variety of partner from the internal alliance and beyond to secure the best-available resources supporting the innovation, which finally becomes a part of their market competitiveness (Chesbrough, 2017; Enkel et al., 2009; Gassmann et al., 2010; Mina et al., 2014; West et al., 2014).

It is a classic topic that has been discussed for years in tech-innovation studies and particularly focuses on R&D itself and open-innovation models (Enkel et al., 2009). The interdisciplinary findings clarifying how such framework combines with absorptive capacity (AC) development in the technology transfer process, however, is yet to come. Technology transfer, a key step to innovation and a series of technical processes (Battistella et al., 2016), has been viewed as a parallel line with the development process of AC and even isolated from external knowledge search models in innovation studies. The successful interdisciplinary attempts of process-based review to explore the intersection between these two strands have been very rare. Technology transfer and managerial knowledge transfer are regarded as a separate and independent process which rarely influence each other. On the other hand, international management researchers hold a common view that international joint venture (IJV) serves as an important vehicle to meet the target of successful knowledge transfer (Battistella et al., 2016; Berdrow and Lane, 2003) but overlooked the specific nature of technology transfer and promote innovation.

This study presents a case study on the low carbon technology transfer in the context of IJVs in China for three main objectives: First, firms in such industry are known for complementing heavy investments in R&D with external knowledge acquisition so that they may learn to adapt their products and technologies being transferred to the local market conditions. It provides a very interesting laboratory for us to explore how this technology transfer works. Second, as ventures in this sector increasingly pursue strategic alliance between MNCs, they are more likely to experience the need to start new learning trajectories from the technology itself to managerial aspects. According to Rai et. al. (2014), there are 42 international strategic alliance or partnership of technologies relating to electric vehicles, solar power and efficient use of conventional energy between China and foreign partners from 2008 to recent five years. Rai and Funkhouser (2015) believe that even if the R&D expenses of strategic alliances may vary on a case-by-case basis, it would still be a quite costly investment considering many of renewable technologies have not been fully commercialised and need to go through a continuing improvement process. As the Chinese government proposed in the 13th Five Year Plan, low carbon energy is expected to achieve installed capacity of 210 GW, which requires continuous and dramatic investment in international R&D suggested by the NDRC (NDRC, 2017). Therefore, the cases selected by this study could exhibit a high need for knowledge absorption activities. Third, as the increasing global concern towards climate change, there has been an emerging debate on how international business can contribute to the UN Sustainable Development Goals (Kolk, 2016), this study echoes the call and provides empirical evidence on the role of IJVs in progressing the adoption of low carbon technology.

The central question for this paper then is how do IJVs conduct external knowledge search via intermediaries in the AC development process in IJVs technology transfer? To classify, understand and evaluate the strategy that IJVs work with intermediaries to promote absorptive capacity so as to achieve technology transfer, this research paper mainly interrogates two types of intermediaries, i.e. research institutions and business associations. It provides a process-based review for technology transfer procedures and studies the contribution of external channels to support AC development.

2. Literature Review

2.1. Intra-Firm Knowledge Acquisition/Transfer

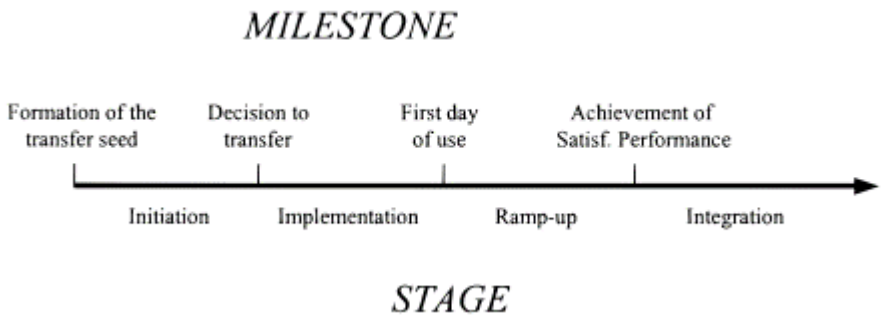
There is increasing evidence showing that although the incoming technology flows itself is important, it could not be applied without the support of efficient organisational structure, project management, experienced staff, etc. (Zahra, 2015)., which also constitutes a part of technological capabilities and impacts the effects of technology transfer projects even the innovation strength of the firms (Mowery, 1996; Tsai, 2001). In addition, technology transfer projects usually occur in specific social-technical contexts.

Mowery et. al. (1996) and Tsai (2001) suggest that knowledge transfer from an inter-organisational perspective refers to the sharing or disseminating of knowledge from one organization to another. It usually occurs in a specific strategic alliance or resource-sharing network, in which one partner acquire technology-related managerial knowledge from other members (Inkpen, 2000; Mowery et al., 1996; Tsai, 2001). The targets of the transfer could include project experience, expertise, organisational knowledge, management methods and knowledge relating to local contexts and cultural difference (Inkpen, 2000; Mowery et al., 1996). The management studies tend to view both recipient and supply side of knowledge transfer as partners of a 'strategic alliance'(Mowery et al., 1996; Tsai, 2001), which is different with innovation studies, which usually do not emphasise the partnership nature of technology transfer projects (Battistella et al., 2016). Such strategic alliances are often led by a joint strategic goal of development, which may benefit all firms in the alliance in a certain period (Inkpen and Tsang, 2005; Mowery et al., 1996; Tsai, 2001). Strategic alliances can have a variety of organizational arrangements, such as joint ventures (JVs), licensing agreements, distribution and supply agreements, research and development partnerships, and technical exchanges(Mowery et al., 1996; Tsai, 2001).

Szulanski (2000) sketches the basic knowledge transfer processes from initiation to integration. He suggests that the knowledge transfer process is composed of four distinct stages, as figure

1 illustrates. Similar to general technology transfer processes, the knowledge transfer often starts up with a common goal, then put the decision into practice. As knowledge flows accumulate, the recipient could start to use and improves the proficiency of understanding, skills or operational processes. After receiving satisfactory performance, the demand side of knowledge could finally integrate the transferred knowledge into daily use. Sulanski (2000) believe that the milestone of such transfer is the key step between the beginning of transfer projects and the 'first day of use', which decides the success of knowledge transfer.

Figure 1 The process of knowledge transfer (Source: Szulanski, 2000)



In a broader sense, knowledge transfer has been also viewed as a part of knowledge management. Inkpen (2000) defines knowledge management as a multi-staged process to finally create new knowledge and innovation, which involves sharing of individual knowledge and its evolution to a collective state, the embedding of new knowledge in products and services and the transfer of knowledge across the organization. Lane and Berdrow (2003) agree with Inkpen (2000) on the multi-stage nature of knowledge process and activities involved at each stage but insist such a process should serve the objective of strengthening strategic advantages. Pak et. al. (2015) noticed the changed contexts of knowledge management and break down the process into four stages in a clearer way, which covers migration, adaption, creation and reverse migration of knowledge. There are distinguished activities, such as transfer, modification, exploration and harvest of knowledge for each stage as well.

Table 1 Comparison between Different Explanations of Knowledge Management Process

Scholars	Stages	Definition	Activities
Inkpen (2000)	Knowledge Sharing	Firms share useful knowledge of product/service design and management with other members in the alliance.	Knowledge Teaching and Learning
	Evolution	Adapting individual firm's knowledge to the collective state of the alliance.	Minor changes and modifications to fit practical needs.
	Application	Embedding of new knowledge in products and services.	Changing management practice based on learned knowledge.
	Innovation	An alliance may generate knowledge that can be used by parent firms to enhance strategy and operations in areas unrelated to the alliance activities.	The transfer of knowledge across the organization
Berdrow & Lane (2003)	Transfer	'Accepting what the partner does, integrating it into one's own systems or changing one's own resources without really understanding why or how it works'	Buying technologies, observing, imitating, changing existing technologies.
	Transformation	'Integration, application and leveraging of contributed knowledge and the creation of new knowledge as a result of the joint activities.'	Develop solutions based on existing knowledge to handle new challenges in IJV's business.
	Harvesting	'Flow of knowledge from IJV to the parent where it can be applied to other internal activities or external alliances.'	Learning within the IJV and by the parent.
Pak et. al. (2015)	Migration	'Each parent transfers its organisationally embedded knowledge to the IJV'	Knowledge transferred from experts of parent companies to the novice of IJVs.
	Adaption	'Knowledge must be adapted and modified according to the environment in which the organisation operates.'	Re-contextualisation of knowledge to fit the new environment of IJV, such as dissimilar locations, unique institutional context. New organisations, etc.
	Creation	'New knowledge is created through an organisational learning process in which individuals of an IJV digest and combine different transferred knowledge via internationalisation and socialisation'	Searching, Variation, Experimentation and innovation.
	Reverse Migration	Capturing knowledge from IJV operations and transfer back to parent com-	IJV-created and IJV-embedded knowledge being transferred back to parent companies.

		pany where the knowledge may be applied.	

By comparison, the scholars above all agree with the multi-stage nature of knowledge management but have a different description on specific stages. Although their definitions name each stage in different ways, basically it covers the process of knowledge transfer, adaption/modification, innovation/creation and harvest/reverse migration. However, the main difference that Pak et. al. (2015) achieved comparing with Inkpen (2000), Lane and Berdow (2003) is a clear delineation of knowledge flow direction. Following the definition of Pak et. al. (2015), it is easy to trace the knowledge location and moving trends throughout the full circle of knowledge management as the figure 1 shows. Migration, for example, shows the knowledge owned by parent company transferring to the IJV. Reverse migration, on the contrary, depicts the knowledge generated in IJV transfer back to its parents.

In summary, no matter the assumptions that the technology transfer or management framework from the two strands of research areas hold, successful knowledge flows experience four stages in the pace of technology transfer. This four-staged technology transfer process framework allows us to further analyse the analyse the knowledge flow and managerial interaction between the parent firm and IJV at different stages.

2.2. The Development of AC – A Process-based Review

Cohen and Levinthal (1989) used the term absorptive capacity to describe a firm's ability to recognize the value of new external information, assimilate it and apply it to commercial ends. As further research progresses, scholars have updated their understanding on absorptive capacity, especially for its power in converting the knowledge gained from external sources into ideas, products, goods, services, and models that could be put into practice (Zahra and George, 2002). This process of knowledge conversion—the translation of abstract knowledge into more concrete prototypes, designs, etc.—make it possible to exploit externally generated knowledge (Zahra and George, 2002). As such, new conceptualizations of absorptive capacity highlight

effective exploitation of knowledge gained externally or by integrating them with the firm's own knowledge base (Zahra and George, 2002).

Absorptive capacity can be further divided into potential and realised ones. The potential absorptive capacity makes the firm receptive to acquiring and assimilating external knowledge, which contains two strands: knowledge acquisition and assimilation capability (Zahra and George, 2002). The first one indicates 'a firm's capability to identify and acquire externally generated knowledge that is critical to its operations' (Zahra and George, 2002), whilst assimilation capability refers to 'the firm's routines and processes that allow it to analyse, process, interpret and understand the information obtained from external sources' (Zahra and George, 2002). Realised absorptive capacity is made up of transformation capability on one hand that can be defined as 'a firm's capability to develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge (Zahra and George, 2002).' Another element of realised absorptive capacity is exploitation capability, which describes a firm's capability to apply the newly acquired knowledge in product or services that it can get financial benefit from (Zahra and George, 2002).

AC by breadth refers to the extent to which the knowledge contained in the firm's absorptive capacity is multifaceted and comprehensive in its coverage of a multitude of fields (Zahra et al., 2015). As a result, absorptive capacity could be narrow (covering only a few fields) versus broad (covering a wide range of fields). In contrast, depth refers to. Depth could form a continuum ranging from shallow (where the firm has some or even a superficial level of skill in a given field) to deep (where the firm has great expertise in a given field). Plotting the orthogonal dimensions of depth and breadth provides some insights into the strategic value of absorptive capacity vis-a-vis technological innovation, as shown in table 2.

Table 2 Classification of AC (Zahra and George, 2002; Zahra et al., 2015).

Classification	Specific Capabilities	Definitions	Examples
Potential Absorptive Capacity	Knowledge Acquisition Capability	'A firm's capability to identify and acquire externally generated	The number of years of experience in the R&D department, the amount

		knowledge that is critical to its operations' (Zahra and George, 2002)	of R&D investment
	Assimilation Capability	'The firm's routines and processes that allow it to analyse, process, interpret and understand the information obtained from external sources' (Zahra and George, 2002)	The number of cross-firm patent citations, the number of citations made in a firm's publications to research developed in another firm.
Realised Absorptive Capacity	Transformation Capability	'A firm's capability to develop and refine the routines that facilitate combining existing knowledge and the newly acquired and assimilated knowledge' (Zahra and George, 2002)	The number of new product ideas, the number of new research projects initiated
	Exploitation Capability	'A firm's capability to apply the newly acquired knowledge in product or services that it can get financial benefit from' (Zahra and George, 2002)	The number of patents, the number of new product announcements, the length of the product development cycle
Absorptive Capacity by Breadth	Narrow absorptive capacity	A firm's absorptive capacity that could cover only a few fields for technological innovation(Zahra et al., 2015).	The firm has knowledge and products in only a few fields. As a result, the firm's product lines are limited.
	Broad absorptive capacity	A firm's absorptive capacity that could allow a wider range of fields for technological innovation (Zahra et al., 2015).	The firm has knowledge and products to engage in different fields and areas thus benefit from creating new product platforms, harvesting different sources of knowledge.
Absorptive Capacity by Depth	Shallow absorptive Capacity	A firm's absorptive capacity indicates that the firm has some or even a superficial level of skill in a given field (Zahra et al., 2015).	The firm has limited ability to engage in technological innovation in the given field. The firm's existing product lines are apt to be old and even decaying.

	Deep absorptive capacity	A firm's absorptive capacity that could develop expert-type mastery of a particular technological domain (Zahra et al., 2015).	The firm has great expertise in a given field, thereby could upgrade existing products and processes.

Some scholars claimed that the specific organisational learning processes, i.e. explorative, transformative and exploitative ones, could influence the development of specific AC (Lane et al., 2006: 856). Exploratory learning, for example, refers to the acquisition of external knowledge and could improve potential absorptive capacity (Lane et al., 2006: 856). Transformative learning means the maintenance of knowledge over time, which may lead to exploratory learning (Lane et al., 2006: 856). Exploitative learning process points to the implementation of acquired knowledge and creates realised absorptive capacity. These learning processes help to build dynamic capability within the firm, which matches different knowledge search strategies depending on the modes (Lane et al., 2006: 856). Therefore, it is helpful for organizations to develop different knowledge search strategies facilitating the acquisition of external knowledge, which is also necessary for completing their learning processes.

2.3. Open Innovation, External Knowledge Search and Intermediaries

Knowledge search mechanisms could be divided into internal and external ones, which shape the AC. The knowledge search through internal channels signifies that the knowledge comes from the strategic alliance (Daghfous, 2004). In the case of IJVs, this means the knowledge transfer from the parent companies and other affiliated firms (Berdrow and Lane, 2003). Knowledge search through external channels, in contrast, refers to seeking knowledge beyond the strategic alliance (Laursen and Salter, 2006). The previous studies have focused primarily on knowledge search through the internal channels, featuring its links with AC (Ferreras-Méndez et al., 2015; Laursen and Salter, 2006). However, knowledge search through external channels is also an interesting topic which remains many research gaps for the academics to explore (Ferreras-Méndez et al., 2015). One of them is the role of external channels in AC development process at different stages and processes (Ferreras-Méndez et al., 2015).

External knowledge search is a term used by innovation studies and often associate with open innovation (Ferreras-Méndez et al., 2015; Laursen and Salter, 2006; Mina et al., 2014). In contrast with closed innovation, the open innovation means an organisation collaborates with partners outside their organisational boundary or outsource part of their R&D jobs to other institutions (Chesbrough et al., 2006; West et al., 2014). Chesborugh et. al. (2017) claim that the industry is experiencing a transition from closed innovation to open innovation, which enables the companies to draw from both internal and external sources for innovation and sell the new product to existing market, potential market and other firms. In the new paradigm, as Laursen and Salter (2006) believe, the external knowledge does not flow to firms automatically and company managers should design specific search strategies to fit the external environment where their companies situate.

The search strategy of an individual firm experiences the restrictions of the external environment (Mina et al., 2014). The contextual factors comprise the availability of technological opportunities, the degree of turbulence in the environment and the search activities of other firms in the industry (Laursen and Salter, 2006). In addition to the environmental limitations, the firm's search strategy is also shaped by a variety of managerial choices, especially past experiences, existing knowledge and future expectations (Laursen and Salter, 2006). Though the best possible search strategies are usually difficult to define, there are two dimensions could be used to measure the range and effectiveness of the external knowledge search strategies(Ferreras-Méndez et al., 2015; Laursen and Salter, 2006; Mina et al., 2014). Laursen and Salter (2006) put forward external search breadth and depth to indicate this. The first concept refers to how many external sources that the firms draw from, whilst the other points to the extents that the firms make use of such external sources. Laursen and Salter (2006) find that the organizations which conduct broader and deeper search may have a greater capacity to change and innovate.

Within such an open innovation context and external search processes, Howells (2006) reveals a range of actors may involve as 'intermediaries', who may smoothen the technology transfer or innovation as a whole. In his definition, intermediaries refer to agents of the innovation

system that facilitate the process of technology/knowledge transfer among people and organizations addressing factors enabling or constraining, they intervene in the process acting as mediator/facilitator between the parties to facilitate the relational context, and with the objective of supporting the process (Howells, 2006). This concept, followed by a classification of different intermediaries in 5 types, describes the role of specific intermediaries at different innovation stages (Howells, 2006). Table 3 reports the roles of intermediaries in each type.

Table 3 Intermediaries by Types (Howells, 1999; 2006)

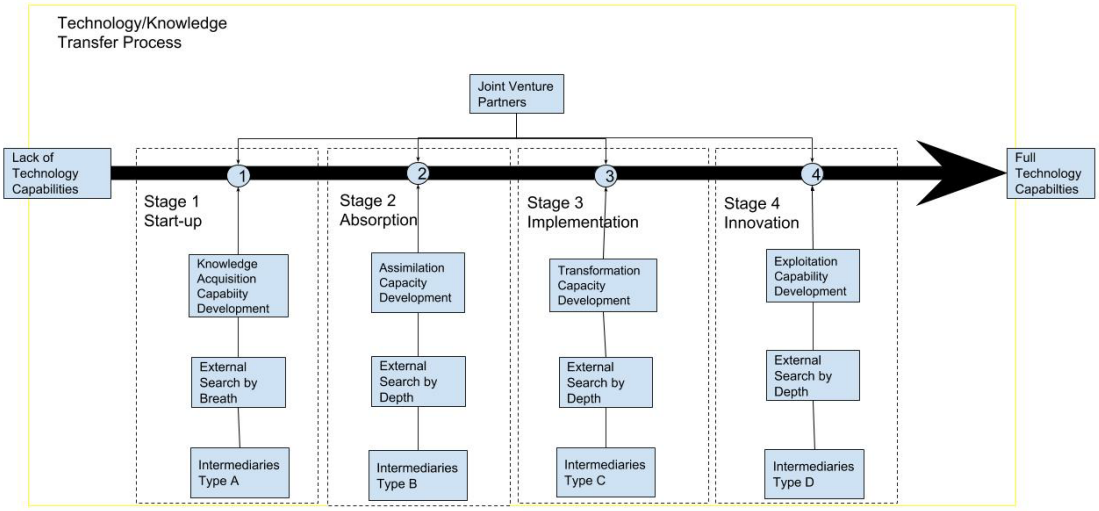
Classification of Intermediaries	Definitions
Consultants	'Independent professionals or organizations involved facilitating the decision-making process supporting the process of innovation which not only facilitates the negotiation and interaction between parties but also help to improve the company management' (Howells, 2006)
Technology broker	'Agents that facilitate the spread in a social system of new ideas from the outside, support innovation by combining existing technologies in new ways, fill information gaps and knowledge in industrial networks' seeking to develop new applications for emerging technologies outside the scope of their initial development, figures are intermediaries between suppliers and users of proprietary technologies' (Howells, 2006).
Agents of innovation	'Service companies that serve as intermediaries within the systems of innovation' 'adapted solutions available on the market to meet the needs of the individual user', 'facilitate the measurement of the intangible value of knowledge' (Howells, 2006).
Intermediation agencies	'Public and private organizations active in the formulation of policy research, in the promotion of change within scientific networks and local communities, in support of technology' (Howells, 2006).
Innovation centre and other institutions:	'The organizational units that support local innovation and business development, for example by collecting the knowledge and skills necessary to enable the transfer process of innovation, serve as a support function for the lack of links in a network, intermediary level organizations that help to steer the system towards scientific socioeconomic objectives' (Howells, 2006).

Those intermediaries do not only become an external source of technology or help to deliver the knowledge search, but also facilitate the whole process of innovation. In this regard, Howells (2006) summarises the role of intermediaries into five parts, namely information 'gathering' and 'scanning', training and mutual learning, communication/bridging, consultation as well as collaborative R&D.

3. Conceptual Framework

The conceptual framework (Figure 2) specifically explains the blueprint of this study. It is constructed on the basis of relevant theories on intra-organisational technology/knowledge transfer, external knowledge search and intermediation in innovation to answer the research questions as stated in the introduction. The conceptual framework also shows theoretical assumptions to guide the design of questions for semi-structured interviews. The data collected in accordance with the conceptual framework should test the correctness of assumptions and provide evidence for academic findings to solve the problems stated above.

Figure 2 Conceptual Framework



After reviewing the recent literature, this study proposes three assumptions to answer the research question as follows:

Assumption 1. At different stages of technology/knowledge transfer, IJVs may need a different level of AC. Firstly, the paper understands the core intersection between technology transfer and knowledge transfer is the building of technology capabilities, which finally determines the firm's innovation strength and performance. Based on technology capability-building in IJVs, there are four stages featuring start-up, absorption, implementation and innovation. It matches different absorptive capacity, external search strategies and intermediaries' types. At the start-up stage, for example, the IJV may need knowledge acquisition capabilities to firstly obtain the

technology/knowledge flows from the parent company. The process accordingly

Assumption 2. Based on distinct characteristics of technology/knowledge transfer stages and the need to develop specific AC, the IJV may design appropriate strategies to conduct an external search for essential resources and information. In terms of intermediation, it means to sustain a range of interaction relationship with agents delivering innovation and consultation services.

Assumption 3. IJVs could resort to different categories of intermediaries to strengthen different absorptive capabilities depending on the stage of technology transfer/cooperation. The role of intermediaries by each type varies and their involvement in the technology transfer process deserve multi-staged analysis. The innovation partners, such as universities and innovation centre, for example, often appears at the implementation and innovation stage. It would be hard to imagine the IJV without technology capabilities at certain levels could collaborate with universities on joint R&D projects or staff exchange programmes.

4. Methodology

4.1. Sample and Data Collection

Our sample cares are three IJVs operating in the low carbon industries in China. Particularly, these three medium-sized IJVs supplying energy conservation equipment for power plants in Zhejiang and Shanghai.

The researcher collected data from two groups of informants with the same interview questions with to increase the validity of our study. Senior managers were identified as the first group of informants for testing the assumptions relating to the management of joint ventures and the strategic alliance as they do have a very good overview of their respective companies. As general managers interact with employees from all functions, they were regarded as the best persons to report the characteristics prevailing in their organizational context. In addition, we iden-

tified director of the technical department, chief engineer or employees with an equivalent position as the second group of informants for testing the assumptions in relation to the firm's external interaction with intermediaries (i.e. direct links with universities). The research chose directors of the technical department because they are assumed to possess the most knowledge about the technological aspects of the company and are responsible for organising search activities as well as new product development projects. We identified the person accountable for the technical activities through requesting personal confirmation from the interviewees at the very beginning of data collection. As the two informants represent different occupational cultures within the organization (i.e. the executive and engineering cultures), respondent biases should not be a major concern in our study because their responses are used for testing different assumptions. Furthermore, our multi-informant design is consistent with prior research in the field.

Data collection was carried out between January and August 2018. During this phase, we first contacted the companies by telephone, text messages or emails to present the study, identify the right informants, obtain their consent and encourage their participation. Those who consented the interview will receive a copy of the questions outline in order to familiarise themselves with the questions before formal meetings. The questions were administered online using the One-note, Microsoft Word and Nvivo in both English and Chinese as the researchers' working language is sometimes different from the interviewees. The two versions are often compared from word to word to ensure that the informants could accurately comprehend the questions, especially the key terms and concepts appear in the interview questions. In addition, the result of pre-tests was confirmed by both supervisors and the interviewees. They believe there were no indications that might cause problems.

5. Findings and Discussions

A. Assumption 1: The Needs to Develop Specific Dimensions of AC by Technology Transfer Stages

All three IJVs experienced different barriers for technology/knowledge transfer and require AC by specific dimensions. The needs to develop specific AC depends on the progress of technology capabilities, which gradually grew from the start-up to the innovation stage.

At the start-up stage, all the IJVs under examination needed to first acquire the technology/knowledge from the parent company. The transfer was conducted through technical materials and IPR transfer. In the meantime, both Chinese and foreign managers needed to work out the IJV's organisational structure and fundamental institutions for business, techniques and human resources, etc. Most of these efforts might relate to knowledge acquisition capability of AC development.

As IJVs were founded based on the conclusion of contracts and started the business, the main focus of the IJVs across three cases at the absorption stage moved to assimilation challenges. Our interview feedback suggests that the managers and engineers of IJVs were not satisfied with the superficial understanding of technical documentation or company rules of project management and could not simply apply it to the production or project implementation. They were expected to learn the know-how, knowledge, expertise and related management strategy behind the technology product being transferred. It usually means the technical team of IJVs to study day-to-day engineering process and methods in detailed 'manuals' while receiving intense on-site training for operation. Meanwhile, managerial staff also needed to familiarise themselves with mixed management methods, including strategic planning, HR administration, marketing which integrated the two types of culture and codes of practice. The main AC development task in regard was the building of assimilation capability.

With the well-trained team of engineers and project managers, the IJVs was then able to implement the projects to test the proficiency of engineering operation skills. In the initial period of this stage, however, the technicians and managers often did not possess the full capabilities to implement the first few projects independently, manufacture the first several batches of products or they could not guarantee the quality of the engineering work/equipment. The project

implementation for the first several orders was usually under the direction of senior and experienced engineers coming from foreign parent companies. As production/implementation capabilities gradually grew, the IJVs then learned the details of engineering practice and had the full confidence in implementation.

As technology capabilities increased, further innovation was expected. The first few independent inventions of IJVs was the result of adapting the transferred technologies to local market conditions so that it could satisfy the needs of clients and increase product competitiveness. Although not all IJVs experienced this stage, the interview scripts from managers and engineers reveal that this would be the common practice in the sector and the leading IJVs in the sector are usually expected to complete the transition from coping to creation, and successfully sells its new products to the market. Innovation in these cases often signifies the ways to solve problems in specific social and technical contexts based on the combination of existing and new knowledge, which finally should work well and deserve full commercialisation. It initially comes with an idea then developed to be a profitable product that could satisfy the needs of the public. As such, the basic demand for this stage is developing exploitation capability of AC.

B. Assumption 2: The Quest for External Knowledge Search Strategies

The knowledge search strategies of the three IJVs follow the same rationale, which is seeking for different types of information by technology transfer stages. At the start-up stage, those IJVs searched for the knowledge that helped them to develop knowledge acquisition capability. It means the IJVs needed to learn the knowledge relating to both Chinese parent and foreign parent so that it could understand what kind of prior knowledge it has and what knowledge/technologies it requires. For the reason, the three IJVs in the case studies used broadly search for the knowledge in relation to knowledge acquisition, which is also known as external knowledge search by breadth. The absorption stage, in the same way, relates to the knowledge search efforts to find the solution restructuring firm routines and processes to absorb the technologies being transferred. From this stage, the IJVs often conducted knowledge search by depth as the search endeavours are more focused on the transferred knowledge/technologies

only. The following implementation activities required external knowledge search for routines and processes that put the prior knowledge and newly acquired ones together to prepare for the production and project implementation. According to the IJVs' feedback, the search strategies for knowledge in depth were in place, as well. Finally, the knowledge search for development exploitation capability is critical at the innovation stage, which gathers data, information, knowledge and experience that help to commercialise the new products or technologies. Accordingly, the external knowledge search by both depth and breadth at this stage is common in three cases.

C. Assumption 3: The Development of AC with Intermediaries: Roles of Consulting Company and Industrial Associations in Technology Transfer

In consistency with the needs of AC development and the design of external knowledge search strategies, the three IJVs did approach different intermediaries for assistance. Due to the specific energy sector and local context in China, however, there are only three types of intermediaries relevant with this case, namely consulting companies, industrial associations and universities. The similarities of the three cases embody the interaction with consultation company and industry associations from the start-up stage, which explains why they could obtain the key information to understand technology transfer and the knowledge to support their future R&D and sales.

> *'Our corporation started negotiations for the establishment of IJVs in 2012 until the beginning of 2013. Nonetheless, we concluded a technology transfer agreement between parent companies but was not able to set up a joint venture company. As we were unsure about their technologies and needed to investigate and observe their product performance. Therefore, we employed a law firm specialising in environmental business and IPR to help understand the technologies of our potential partners, especially its low emission figures.'*
>
> - *Case C*

So to speak, the consulting company, i.e. law firms, accounting firm or patent firms could help the IJVs to identify and understand the technologies and knowledge being transferred

from the parents and even other sources. This is paricularly crucial at **start-up stage** because the IJV managers and engineers need to confirm whether the technology being transferred has economic and technical values. The professional consulting companies could improve their **knowledge acquisition capability** in delivering the investigation.

Apart from them, our cases illustrate that academic institutes and industry association are the two most important intermediaries which play different roles at different stages of AC development in our cases.

The Role of University-Firm Collaboration at Different Stages of AC Development

> *'We have cooperation with prestigious universities in Shanghai and Zhejiang which are famous for their engineering and sci-tech research. Our partnership is based on policy development and technology R&D, which was started when we implemented several projects and experienced new technical problems which could not be solved by existing technical solutions.'*
>
> - *Case A.*
>
> *'We partnered with sci-tech universities in our province, when we manufactured and implemented several projects and experienced the "bottleneck" of technical issues. They can help us to do some experiments which we might not have the labs or experiences.'*
>
> - *Case B.*

The IJVs in Case A and B did work with the same type of intermediaries from the implementation stage to the innovation stage. After the successful accumulation of technological capabilities **at implementation stage**, they cooperate with local universities to operate joint R&D programmes.

> *'Our country's basic theoretical research in this area is still relatively backward, so in many aspects, our company must build laboratories to do experiments and the R&D when we experienced technical problems in our daily business. Some research teams even need experimental plants and equipment for flow field simulations, etc. to determine the key empirical parameters. In addition, as the largest energy consumption country in the world, China's energy supply is more complicated than other countries and the situation is not the same everywhere in the country. The foreigners cannot*

provide ready-made solutions once for all and we must explore the solutions by ourselves. In terms of finance, the capital that support our daily operation could not afford the large-scale investment in scientific research of fundamental research.'

'The specific cooperation programmes for R&D include sharing laboratories, personnel exchange visits, university graduate internship, jointly undertaking public research projects or entrusting the universities to do private projects. Basically, they can help us to do some experiments and testing, etc.'

- *Case B.*

'Adaption is an unavoidable problem for us and any other suppliers requiring the technology transfer in the sector. The transferred technologies originate from their native country and targeted at the needs of the customers there. However, it may not apply to the Chinese context and even different provincial situations. Therefore, we need to put forward new solutions to adapt it. We often commissioned universities to do this or do it with them.'

- *Case C.*

The university-firm collaboration helped them to solve adaptability problems of their products and facilitate the AC development, especially **transformation capability** and **exploitation capability**. Since the transferred technologies are not ready-to-use in many cases, the IJVs often need to adapt the transferred technologies to the local context, which requires a heavy investment in R&D. Given the fact that the relevant research in China has not developed to an advanced level and limited funds that the IJVs could invest in the R&D, it is a cost-effective way to collaborate with universities for sharing the research facilities and conducting collaborative research to solve the practical problems that affects the product/equipment performance.

'We need to develop some cutting-edge R&D and inventions to maintain our market advantage. As many researchers also serve as government consultants, who actually draft the policy document/technical standards or discuss it at a policy meeting or conference. By approaching university experts, we can know the future trends of industry development and industry policies, which is beneficial to our product development.'

- *Case B.*

At innovation level, the IJV did not only maintain the collaborative R&D partnership with the universities but also searched for information and knowledge relating to new trends

and dynamics of energy policies and the sector via university experts. By doing so, the company could ensure that the product development projects comply with the regulation, technical standards and market conditions, therefore smoothen the commercialisation.

> *'Our joint venture has not cooperated with the universities yet, because our current technologies being transferred has not been fully absorbed and there is no realistic need……When we realised there is a technical problem, we requested for foreign parent company to solve it.'*
>
> - *Case B.*

In contrast, the IJV in Case C has not managed to resort to universities, to strengthen AC. Although the IJV lack of assimilation capability at the absorption stage and transformation capabilities at the implementation stage, it did not draw from universities or other external sources for experimental knowledge or engineering experiences. In comparison with the other two cases, it is a critical overlook of external search strategies, which may become one of the reasons for its current business dilemma and unsuccessful transition to the innovation stage.

The Role of Industrial Associations at Different Stages of AC Development

Not all of three IJVs approached industrial associations for the access to sectoral updates and policy information. In fact, the majority of Chinese energy sectors are composed of SOEs which have direct access to government and policy-makers for such information. Thus, the industrial associations may not be the best available source.

> *'We are a subsidiary firm of the parent companies therefore we automatically become a part of associations along with our parent companies. As almost all big energy enterprises in China are SOEs, we have the direct links to general information about policy trends and sectoral dynamics. In this sense, business associations are indirect media to get the information, which is not very helpful. However, we do need to cooperate with those business associations which have a say in the standard-making issues. This often involves with the new standards of emissions, which on the one hand increases our innovative strength, on the other hand promotes our sales. '*
>
> *'Those industrial associations organised a series of standard-making committees for each category of energy technologies. We were invited to participate and communicate with the most authoritative scientists on certain technical standards. In the process of drafting and editing, we learned much experiences from the colleagues and experts, while advertising our products and processes. The new standard we proposed*

reflects the innovation achievement that base on the integration of existing paradigm and new knowledge we created from R&D or accepted from technology transfer.'

- *Case A.*

Instead, the industrial associations, epically those influential ones i.e. China Eletricity Council, offered a platform for IJVs to further promote its innovative strength in the process of standard-making. The invited enterprises and experts represent the prestige of the relevant field. In the process of standard-making, the industrial associations create a space for the first-class innovators to share and communicate so that the IJVs could learn from experience of others big 'players'. The drafting and editing of relevant technical standards, moreover, involves the summarisation and integration of exisitng knowledge and new technical updates. It often triggers the development of **exploitation capability** at the **innovation stage**, which highlights the experience of IJVs in Case A and B.

'We are the member of multiple sectoral associations featuring energy conservation, environmental protection, electricity and mechanics. We obtained policy information from their conferences and workshops, while using online databases to search for technical updates and market changes. However, they are mainly directional and don't give much details or specific guidance. For more direct information, we mainly approach local officials for assistance.'

- *Case C.*

However, the IJV in the Case C have not gone this far. It did not even achieve the innovation stage, therefore was not able to be invited to make the 'rules'. The industrial association played a role in offering complementary information sources rather than a platform for R&D experience sharing.

6. Conclusion

The research paper further the understanding of the role of external knowledge search and intermediaries to facilitate AC development in the process of technology/knowledge transfer. It identifies three assumptions based on the research question and answers how do IJVs work with external channels/intermediaries to promote the AC development process at multiple

stages of technology/knowledge transfer. Combining the intra-organisational technology/knowledge transfer framework, AC development process and external knowledge search strategies, the study actually builds a bridge across innovation studies and management studies in the sector of coal-fired power plants.

Moreover, our study implies several directions for the practitioner. The work suggests that to pursue successful AC development and achieve higher innovation levels, firms should select different intermediaries for collaboration depending on its needs at a specific stage of technology/knowledge transfer. Thus, managers should design specific search strategies and AC development methods to fit the characteristics of each technology/knowledge transfer stage and work with a specific type of intermediaries. One way to achieve this, for example, is by sustaining deep relations with certain intermediaries, such as consultation company, business associations or universities, to access external sources. However, managers should also bear in mind that the mere fact of intensively drawing new ideas from external sources will not always guarantee improvements in firm performance. The strategies to approach certain intermediaries must meet the needs of companies in specific social-technical contexts, depending on the technology/knowledge transfer progresses.

It is necessary to point out several intrinsic limitations of this research. First, as we use in-depth case analysis, the number of case studies was limited to three, which leads to the limitation of sample size. Second, the study only focuses on IJVs that still exist and could imply survivor bias. Third, after the first session of data collection, the researcher enquired of the informants for the recent updates by telephone and text messages instead of organising the second in-person meeting, which may be another limitation. Last but not least, since the study applies inductive analytic approach consuming considerable time to process a huge amount of data, there may be more details to be reported in the next several months.

Bibliography

Battistella, C., De Toni, A.F., Pillon, R., 2016. Inter-organisational technology/knowledge transfer: a framework from critical literature review. J. Technol. Transf. 41, 1195–1234.

https://doi.org/10.1007/s10961-015-9418-7
Berdrow, I., Lane, H.W., 2003. International joint ventures: creating value through successful knowledge management. J. World Bus. 38, 15–30. https://doi.org/10.1016/S1090-9516(02)00106-2
Cassiman, B., Veugelers, R., 2006. In Search of Complementarity in Innovation Strategy: Internal R&D and External Knowledge Acquisition. Manag. Sci. 52, 68–82. https://doi.org/10.1287/mnsc.1050.0470
Chesbrough, H., 2017. The Future of Open Innovation: The future of open innovation is more extensive, more collaborative, and more engaged with a wider variety of participants. Res.-Technol. Manag. 60, 35–38. https://doi.org/10.1080/08956308.2017.1255054
Chesbrough, H.W., Vanhaverbeke, W., West, J. (Eds.), 2006. Open innovation: researching a new paradigm. Oxford University Press, Oxford.
Cohen, W.M., Levinthal, D.A., 1989. Innovation and Learning: The Two Faces of R & D. Econ. J. 99, 569. https://doi.org/10.2307/2233763
Daghfous, A., 2004. Absorptive capacity and the implementation of knowledge-intensive best practices. SAM Adv. Manag. J. 69, 21–28.
Enkel, E., Gassmann, O., Chesbrough, H., 2009. Open R&D and open innovation: exploring the phenomenon. RD Manag. 39, 311–316. https://doi.org/10.1111/j.1467-9310.2009.00570.x
Ferreras-Méndez, J.L., Newell, S., Fernández-Mesa, A., Alegre, J., 2015. Depth and breadth of external knowledge search and performance: The mediating role of absorptive capacity. Ind. Mark. Manag. 47, 86–97. https://doi.org/10.1016/j.indmarman.2015.02.038
Gassmann, O., Enkel, E., Chesbrough, H., 2010. The future of open innovation: The future of open innovation. RD Manag. 40, 213–221. https://doi.org/10.1111/j.1467-9310.2010.00605.x
Howells, J., 2006. Intermediation and the role of intermediaries in innovation. Res. Policy 35, 715–728. https://doi.org/10.1016/j.respol.2006.03.005
Inkpen, A.C., 2000. Learning Through Joint Ventures: A Framework Of Knowledge Acquisition. J. Manag. Stud. 37, 1019–1044. https://doi.org/10.1111/1467-6486.00215
Inkpen, A.C., Tsang, E.W.K., 2005. Social Capital, Networks, and Knowledge Transfer. Acad. Manage. Rev. 30, 146–165. https://doi.org/10.5465/amr.2005.15281445
Kolk, A. 2016. The Social Responsibility of International Business: from Ethics and the Environment to CSR and Sustainable Development. Journal of World Business. 51.1 23-34. https://doi.org/10.1016/j.jwb.2015.08.010
Lane, P.J., Koka, B.R., Pathak, S., 2006. The Reification of Absorptive Capacity: A Critical Review and Rejuvenation of the Construct. Acad. Manage. Rev. 31, 833–863. https://doi.org/10.5465/amr.2006.22527456
Laursen, K., Salter, A., 2006. Open for innovation: the role of openness in explaining innovation performance among U.K. manufacturing firms. Strateg. Manag. J. 27, 131–150. https://doi.org/10.1002/smj.507
Lema, R., Quadros, R., Schmitz, H., 2015. Reorganising global value chains and building innovation capabilities in Brazil and India. Res. Policy 44, 1376–1386. https://doi.org/10.1016/j.respol.2015.03.005
Mina, A., Bascavusoglu-Moreau, E., Hughes, A., 2014. Open service innovation and the firm's

search for external knowledge. Res. Policy 43, 853–866. https://doi.org/10.1016/j.respol.2013.07.004

Mowery, D.C., Oxley, J.E., Silverman, B.S., 1996. Strategic alliances and interfirm knowledge transfer: Strategic Alliances and Interfirm Knowledge Transfer. Strateg. Manag. J. 17, 77–91. https://doi.org/10.1002/smj.4250171108

NDRC, 2017. The 13th Five Year Plan of Energy Development. NDRC Website. Available from: http://www.ndrc.gov.cn/zcfb/zcfbghwb/201701/W020170117350627940556.pdf (Last Accessed on 28 Feb 2019)

Pak, Y.S., Ra, W., Lee, J.M., 2015. An integrated multi-stage model of knowledge management in international joint ventures: Identifying a trigger for knowledge exploration and knowledge harvest. J. World Bus. 50, 180–191. https://doi.org/10.1016/j.jwb.2014.02.006

Rai, V., Funkhouser, E., 2015. Emerging insights on the dynamic drivers of international low-carbon technology transfer. Renew. Sustain. Energy Rev. 49, 350–364. https://doi.org/10.1016/j.rser.2015.04.119

Rai, V., Schultz, K., Funkhouser, E., 2014. International low carbon technology transfer: Do intellectual property regimes matter? Glob. Environ. Change 24, 60–74. https://doi.org/10.1016/j.gloenvcha.2013.10.004

Szulanski, G., 2000. The Process of Knowledge Transfer: A Diachronic Analysis of Stickiness. Organ. Behav. Hum. Decis. Process. 82, 9–27. https://doi.org/10.1006/obhd.2000.2884

Tsai, W., 2001. KNOWLEDGE TRANSFER IN INTRAORGANIZATIONAL NETWORKS: EFFECTS OF NETWORK POSITION AND ABSORPTIVE CAPACITY ON BUSINESS UNIT INNOVATION AND PERFORMANCE. Acad. Manage. J. 44, 996–1004. https://doi.org/10.2307/3069443

West, J., Salter, A., Vanhaverbeke, W., Chesbrough, H., 2014. Open innovation: The next decade. Res. Policy 43, 805–811. https://doi.org/10.1016/j.respol.2014.03.001

Yin, R.K., 2009. Case study research: design and methods, 4th ed. ed, Applied social research methods. Sage Publications, Los Angeles, Calif.

Zahra, S.A., George, G., 2002. Absorptive Capacity: A Review, Reconceptualization, and Extension. Acad. Manage. Rev. 27, 185–203. https://doi.org/10.5465/amr.2002.6587995

Zahra, S.A., Larraneta, B., Galán, J.L., 2015. Absorptive Capacity and Technological Innovation, in: Cooper, C.L. (Ed.), Wiley Encyclopedia of Management. John Wiley & Sons, Ltd, Chichester, UK, pp. 1–5. https://doi.org/10.1002/9781118785317.weom130020

Zhou, Y., Zhang, B., Zou, J., Bi, J., Wang, K., 2012. Joint R&D in low-carbon technology development in China: A case study of the wind-turbine manufacturing industry. Energy Policy 46, 100–108. https://doi.org/10.1016/j.enpol.2012.03.037