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The transfer and creation of knowledge within foreign invested R&D in emerging markets[1]

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Abstract

Purpose – The purpose of this paper is to investigate important impediments to knowledge creation within newly-established foreign invested R&D centers in China and India.

Design/methodology/approach – The paper presents a framework based on knowledge creation theory in order to understand the barriers for transfer and the creation of innovation-related knowledge within newly-established foreign invested R&D units in China and India. The paper utilizes extensive empirical data collected from a case study in three Scandinavian multinational companies (MNCs).

Findings – Examples of innovations in China and India within Scandinavian MNCs are presented. Impediments to these innovations are identified with regard to socialization and knowledge creation. Particular skills of R&D employees in China and India are relevant for process innovations, e.g. competencies in codification of knowledge.

Originality/value – A synthesis of existing knowledge creation theory is applied to compare R&D knowledge creation skills of Chinese, Indian, and Scandinavian engineers, within MNCs. The new framework explains knowledge creation in China and India, and can be used in other foreign invested R&D units in these countries. Implications for managers working with newly established foreign invested R&D units in emerging markets are offered.

Keywords China, India, Scandinavia, Multinational companies, Knowledge creation, Knowledge transfer, Foreign invested R&D, Innovation performance

Paper type Research paper

1. Introduction[2]

Research and development (R&D) in multinational companies (MNCs) is increasing in emerging markets such as China (von Zedtwitz, 2004) and India (Pillania, 2005). This development emphasizes the importance of understanding how R&D in these countries contributes to the innovation performance of companies establishing new R&D units. Studies in mature markets suggest that subsidiary innovation performance can be largely explained by the absorptive capacity and the network position of the subsidiary (Tsai, 2001). These findings are likely to have some validity in emerging market country contexts. However, differences between school systems in China, India, and many Western countries are likely to create implications for innovation-related

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activities within foreign invested R&D units in emerging markets. For instance, many characteristics of the school systems in Asia do not nurture creativity (Johnson and Weiss, 2008). Instead school systems emphasize memorization and neglect creative expression and critical thinking in problem solving. New knowledge creation is, therefore, difficult. Confucianism made a strong footprint on Chinese culture. Within Confucianism, knowledge is perceived to be subjective, serving an instrumental function, rather than being valued for the purpose of self-actualization, as it is in the Western world (Yang et al., 2006).

In China, experiments and knowledge creation per se have not been considered important (Baark, 2007). This is the case even though these activities are important for innovation-related activities, such as R&D, to occur. In spite of these historical and cultural factors impeding innovation, convincing evidence is emerging which shows that innovations with global impact can be created within foreign invested R&D units in countries such as China and India (Immelt et al., 2009).

The contrasting picture presented above calls for further research comparing technical innovations between China, other Asian countries and Europe (Johnson and Weiss, 2008). This paper investigates important barriers to transfer – and creation of – innovation-related knowledge within newly established foreign invested R&D units in emerging markets. A framework, primarily based on knowledge creation theory, is presented to further our understanding of innovation-related knowledge creation in emerging markets, and specifically in China and India.

1.1 Theoretical framework – knowledge creation theory

1.1.1 The SECI model. Socialization, externalization, combination, and internalization (SECI) are four key processes in the SECI model (Nonaka and Takeuchi, 1995; Nonaka and Konno, 1998). The knowledge transformation cycle of the model outlines how tacit knowledge is externalized. When internalized, such knowledge becomes tacit again, as shown in Figure 1. It is interesting to consider this model in relation to the critique expressed by Johnson and Weiss (2008) and Yang et al. (2006) concerning the school system in China and other countries in the region. These school systems may provide few opportunities to nurture socialization skills.

1.1.2 The information space. Chaos is characterized by diffused knowledge which is neither abstract nor codified. It is, therefore, seen as the source of innovations within the Information Space (Boisot, 1995). The Information Space is a three-dimensional model comprising the relational dimension diffusion, as well as the cognitive dimensions of codification and abstraction. Codification and abstraction are at the same time distinct and mutually reinforcing strategies for knowledge creation.

Whereas abstraction provides structure by reducing the amount of categories, data need to be assigned before a phenomenon can be understood. Codification gives data form by assigning categories (Boisot, 1995; Boisot and Child, 1999). The degree to which knowledge is fully documented or expressed in writing is one way of evaluating the extent to which it is codified (Hansen, 1999). In the context of technical development, abstraction can be viewed as something that connects means (i.e. ways of doing things) in terms of relevant technology with codifications and ends, in terms of relevant customer problems and problems in general.

1.1.3 Important skills for transfer – and creation – of innovation-related knowledge. Experienced action and accumulated insights are words describing tacit knowledge,

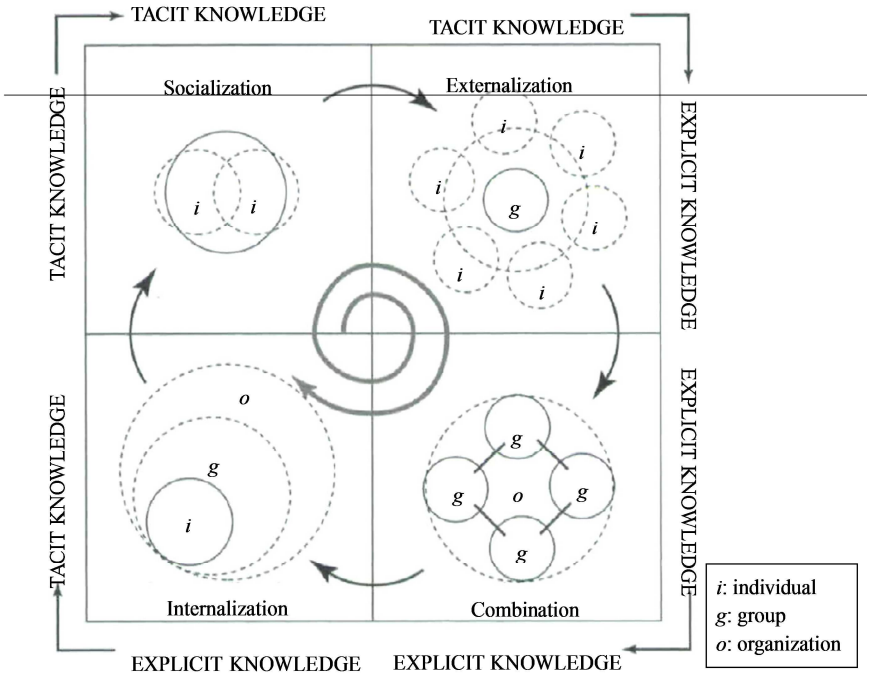

Figure 1. Spiral evolution of knowledge conversion and self-transcending process

which can also be divided into two dimensions: "know-how" and a cognitive dimension concerning how the world is perceived. Transfer or dissemination of tacit knowledge between people relies on socialization (Nonaka and Konno, 1998) and is also important when creating new abstract concepts.

Nonaka and Konno (1998) describe socialization as the capturing and dissemination of tacit knowledge. They stress the importance of physically proximate interaction around joint activities; whereby tacit knowledge is shared between individuals. These authors also emphasize the importance of self-transcending human interaction and joint activities in order for knowledge creation and innovation to occur.

"Know-how" or tacit knowledge that a person has developed is restricted by a person's own perception of this knowledge. By empathically transcending oneself and sharing tacit knowledge with others, new knowledge can be created. When tacit knowledge is shared with others, it is exposed to other cognitive perception mechanisms that may facilitate new interpretations of this know-how. Thereby new knowledge in terms of new innovations and abstract concepts emerges from this process. If knowledge is perceived in a new way, it may change into new forms.

The socialization process results in new knowledge creation. As a means-to-an-end process, it incorporates both abstraction and the diffusion of tacit knowledge. Whereas codification eases the diffusion or transfer of codified knowledge, socialization eases the diffusion or transfer of tacit knowledge. Socialization skills may also determine what socially embedded knowledge a person is able to access.

More concretely, socialization skills may also determine how well customer needs can be identified and understood and how tacit knowledge can be transferred.

Codified knowledge is easier to transfer than tacit knowledge (Teece, 1986, 1998; Lane et al., 2001). However, this is true to the extent that the adequate codification skills needed in order to understand codified knowledge are available (Johnson, 2007). Explicit knowledge can be more or less complex (Nonaka and Konno, 1998). Complex explicit knowledge may be codified, however, even if the recipient of the knowledge does not have the needed codification skills. Codification of knowledge does not necessarily facilitate its transfer (Hansen, 1999).

Codification skills may determine what codified knowledge can be understood, transferred, and used in furthering innovative knowledge creation that can used to solve problems, as proposed in Table I.

Socialization skills may also be an important determinant of a person's ability to create knowledge with other people. For example, socialization skills help an engineer to be able to empathize and understand customers' problems. Such skills can also help engineers collaborate with other engineers. The better codification skills an engineer has, the more codified knowledge it is possible for him/her to understand, and therefore, she or he may have access to a wider, more sophisticated spectrum of possible technical solutions to use in problem solving.

Some problems do not require socialization skills. Codification skills may, therefore, be particularly relevant in relation to technically-oriented process innovations, which focus on solving existing evident problems in better ways, as proposed in Table I.

2. Methodology

The abductive approach (Alvesson and Sköldberg, 1994; Dubois and Gadde, 2002) is the methodological strategy used in this research project. The abductive approach emphasizes theory development as an iterative process of matching theory with reality and vice versa. The researcher moves between empirical data and findings and theory framework. Insights co-evolve in this reciprocal process. The basis for this process is an exploratory holistic, multiple case study (Yin, 2003) that includes extensive qualitative empirical collected information.

We collected information from three Scandinavian companies. A case study is a preferable methodological approach for inquiries into complex social phenomena (Yin, 2003; Eisenhardt and Graebner, 2007). More than 30 semi-structured qualitative interviews were conducted in person and by phone with individuals in the three companies. Interviews occurred between January 2007 and October 2010. Several rounds of interviews have been conducted with the companies in order to track the development of the cases over time. Each recorded and transcribed interview lasted around one hour 30 minutes.

Type of skill	Codification	Socialization
Type of problem where the skill may be particularly relevant	How to solve existing problems better	How to find new problems to solve
Type of innovation where the skill may be particularly relevant	Process innovations	New product or service

Table I. Relevance of codification, and socialization in relation to different types of innovation-related activities

The Mechanic Tech firm has R&D units in China and India. Med Tech has an R&D unit in China. Wind Tech has an R&D unit in India. Engineers and scientists were interviewed in the R&D units in Asia and also in Scandinavia. Interviews were conducted with managers in charge of the overall R&D transfer process, on different levels, as well as expatriates, and other R&D employees working in the R&D units were interviewed.

Secondary data has also been collected in addition to primary empirical data. Internal validity has been addressed for the case studies in terms of the number of interviewees, and their positions in the organizations. The issues of construct validity and reliability have been addressed using key informants to review the case reports. External validity was used by including three relatively different industries, and by developing an industry independent theoretical framework using the abductive approach.

3. Cases

All companies view the establishments of R&D units as successful. All units have experienced very low employee turnover rates.

3.1 Mechanic Tech

The company established an R&D unit in Shanghai in 2006. The primary objective of the establishment of the R&D unit in China was to support the local manufacturing in the country which made it necessary to develop local adaptations, and developments, of the products of the company.

Some R&D-related activities of the company are also located in India. In terms of differences between conducting R&D activities in China and India, some Scandinavian managers perceive the Indian R&D engineers as more proficient and genuinely interested in project processes and procedures than the Chinese R&D engineers. On the other hand, the Chinese engineers are perceived by the Scandinavian engineers as having more individual drive and entrepreneurial spirit than the Indian engineers.

3.1.1 Barriers to transfer and creation of innovation-related knowledge. Engineers in the Chinese R&D unit initially perceived a resource restriction in terms of receiving training from the two R&D units of the company in Scandinavia. Engineering schools in China are competent and Chinese engineers have a reputation for being hard-working. On the other hand, it is not easy for Chinese engineers to collaborate with each other when they leave the educational system and enter industry.

The Chinese educational system is perceived by Scandinavian managers as focusing on the development of individual talent. Engineers in China endure a lot of pressure in their education. Students without top grades in China cannot progress to higher levels of education at more prestigious universities.

Chinese engineers experience problems in taking the initiative and collaborating. They tend to work alone without much interaction. Without interaction, problems are hidden and projects have difficulty succeeding. Deadlines are missed as a result. Successful R&D developments of the unit studied to date would not have been possible without the Scandinavian engineers and their project management expertise. With regard to the lack of interaction, consider the following quote:

> The lonely inventor does not exist anymore. Instead, now it is about groups who are tight and who work together and out of that new breakthroughs emerge (R&D manager, interview, 9 February 2010).

3.1.2 Contributions to innovation performance. Significant cost savings were made by the companies when compared with Scandinavian wages. Civil engineers are paid approximately e800 per month compared to Chinese with PhD degrees who receive e1,700 a month. This is much less than the companies would have to pay similarly educated employees in Scandinavia. The payment levels are increasing: 10 and 20 percent in China; but Scandinavian R&D managers within the same companies anticipate that it will take several years before the wage levels in China will be similar to those in Scandinavia.

In the Scandinavian R&D headquarters of the company, the Chinese engineers working for the company are described as extremely receptive. It is anticipated that they will be able to perform at the same level as the Scandinavian engineers in the near future. Moreover, the Chinese engineers are sometimes performing at higher levels than the engineers in Scandinavia, as illustrated in the following quote:

> I think they are very skilled in development of circuit cards and things which requires hard work. Concerning these things we have relaxed a bit... our schools does maybe not fully support that anymore (Scandinavian R&D manager, interview, 9 February 2010).

So far, no radical innovations have been created in the R&D unit, but it is anticipated that this may change. The Chinese engineers have proven to be proficient at adapting existing products to the less-sophisticated demands of the local market. Also, the Chinese engineers have provided a new perspective, including the notion that a product does not need to contain as much functionality as possible. Products can be "good enough." This is thought provoking to some of the Scandinavian engineers.

The R&D unit in China also provides new thinking with regard to how to manage projects:

> It may be that it is the home base R&D unit in Sweden that learns the most during the process because they are forced to change things that they would never think about if they are not taking part in the development of R&D unit in China. Working with a satellite can in the beginning decrease the efficiency of an R&D unit in Sweden, but in the long run it is an advantage. You get new input in terms of how to document, define, and manage projects (Chinese R&D manager, 19 March 2007).

3.2 Wind Tech

The company established its R&D unit in India around the end of 2006 with 20 engineers. By the beginning of 2010, there were 80 engineers in the R&D unit. The R&D unit has expertise in aerodynamics, structural design, and calculations, finite element analysis, quality control processes, construction, and reliability. The strategy of the company is to perform R&D across the globe. In India, it is possible to access a large, competitive, and cheap workforce. This resource is scarce in the home country of the company.

3.2.1 Barriers to transfer – and creation – of innovation-related knowledge. Many Scandinavian R&D employees think that in order to locate an R&D unit in China or India, it is necessary to control the process tightly. These engineers view the Indian engineers as having difficulties in making decisions and taking independent action. They also think it is necessary to tell them what to do.

In the Scandinavian part of the company, the Indian engineers were perceived as being used to working by themselves, for themselves, and not having a group feeling. Also, the Indian engineers were perceived as being indirect in communicating, and

sometimes hiding information if tasks are not completed by a deadline. Otherwise, the Indian engineers were perceived as being proficient at mathematics and theory, as well as very fond of procedures.

The Indian engineers generally perceive the Scandinavian engineers as being open and straightforward; however, Scandinavian engineers are also seen as being somewhat focused on doing more of the same, as opposed to coming up with new innovations. Indian engineers think that the Scandinavian engineers collaborate, but within their own-specialized groups, as opposed to collaborating across different specialized groups.

At the bachelors degree level in the Indian educational system, practical-oriented university projects are rare. However, at the Masters degree level practical-oriented university projects are more likely. Engineers in the Scandinavian part of the company are accustomed to group work, where each group has to solve single and multiple problems interdependently.

3.2.2 Contributions to innovation performance. Indian engineers have established a cross-sectional innovation group in the Indian R&D unit where ideas are shared. One innovation that was created in the unit addressed the problem that the products of the company are continually increasing. Therefore, the Indian engineers have come up with a revolutionizing manufacturing concept that facilitates products being manufactured in separate parts of the company, instead of in one single mold. The separate parts are then assembled at the final location. This discovery has significantly lowered the costs of the company. Top management supports the new development and has filed patents for the new concept.

The Indian R&D unit has contributed to efforts to shorten the new product development time within the company by 25 percent. The key to this success has been the development of virtual testing systems. Second, they have developed new designs that enable higher performance than existing product solutions. Indian engineers continue to improve the manufacturing processes in the company. Products can, thereby, be manufactured faster and more accurately. Third, the Indian engineers have also developed a way to decrease emissions from the manufacturing process. This is a very environmentally friendly innovation. The last-two innovations have been created as a consequence of an initiative where the Indian engineers have met and shared observations and experiences with employees who manufacture the products of the company. A total of seven patents were filed for inventions stemming from the Indian R&D unit last year. The Indian R&D unit director emphasizes the positive effect of enabling out-of-the-box thinking, which is achieved when R&D activities are transferred to a new environment and new mindsets.

3.3 Med Tech

By the end of 2001, the company Med Tech had established an R&D unit near Beijing. Among other things this was done in order to more easily access the talent base in China. Today, the R&D unit employs close to 80 scientists.

3.3.1 Barriers to transfer and creation of innovation-related knowledge. Initially, several people who applied for job at the newly established R&D unit in China did not meet the needed standards. This was particularly the case concerning recruitment of people at the middle and senior levels. The Chinese recruits were not accustomed to working in applied research. The Scandinavian scientists and managers within the company thought that the Chinese scientists in the R&D unit had been performing

adequately but could have taken more initiative. It appeared they may be afraid to do so since they were accustomed to a more hierarchical management style in China.

The Chinese scientists were, perhaps, pushed to take the initiative too early in the process. In this case, they were not ready for this management style. It was also difficult for the Chinese to cope with the strict project management within the company. Ideas are killed very fast if they are not aligned with the corporate goals. Former Scandinavian expatriates in the Chinese R&D unit thought that there were too many formal meetings and a lot of irrelevant detailed discussions within the R&D unit.

3.3.2 Contributions to innovation performance. The company has experienced a diminishing cost advantage in China. The main work done in the R&D unit is related to protein purification processes. The scientists in the Chinese R&D unit have proven their ability to come up with new perspectives on experiments conducted within the company. As one example, the R&D unit in China has succeeded in improving a process which the Scandinavian R&D organization previously conducted as a three-step process:

(1) break the protein;

(2) filter the protein; and

(3) use chromatographic techniques.

The productivity level was initially very low. The Chinese scientists tried to find the cause of the low productivity. Their result was that the filtering process significantly decreased the productivity. A new chromatography was found that eliminated the filtering process. The overall result was a dramatic increase in productivity.

4. Analysis

4.1 Impediments to innovation

The three companies in this research believed that recruiting new, local university graduates to work in and run the companies would be difficult. As outlined in Table II, serious problems with socialization skills existed in terms of getting R&D employees to collaborate in the companies.

4.2 Contributions to innovation performance

In the case of the disintegrated manufacturing process innovation at the Wind Tech firm, the targeted problem was quite evident to those in the industry. Solving this problem is an example of an important innovation that was triggered by highly-diffused explicit knowledge. The disintegrated manufacturing process from Wind Tech and the

	Mechanic Tech (China + India)	Wind Tech (India)	Med Tech (China)
Socialization skills	China: Some individual initiative without letting anyone know and without collaborating Deadlines are exceeded, and problems hidden, due to lack of interaction	Lacking group feeling Lack of individual initiative Many formal processes. Deadlines are exceeded. Problems are hidden away	Some individual initiative without letting anyone know, and without collaborating Formal meetings with a lot of irrelevant detail discussion

Source: Case data

Table II. Impediments to innovation-related knowledge creation in China and India

improved protein purification process from Med Tech are both process-oriented innovations. These innovations are not examples, however, of addressing a new problem but of solving an existing problem. Process innovations may not require the same socialization skills as other types of innovations where both the problem and the solution are new. This observation could explain why the R&D units in China and India have been able to come up with quite impressive innovations, as mentioned below in Table III, in spite of the existing impediments to innovation.

Proficient codification skills may enable engineers to find inspiration for innovation in codified knowledge which they would otherwise not be able to understand. However, tacit knowledge, e.g. in terms of unarticulated problems, still constitutes a solid foundation for innovation. Wind Tech experienced good results when bringing together people from manufacturing with the Indian engineers. The engineers were thereby exposed to relevant problems to solve, which they successfully did, thereby improving the manufacturing efficiency of the company. Wind Tech runs many projects where Scandinavian engineers and Indian engineers work in the same team. Cross-unit teamwork increases interaction and helps decrease the knowledge gap within the company and between R&D in Scandinavia and R&D in India.

4.3 Case-specific evaluation of important skills for transfer and creation of innovation-related knowledge

In Figure 2, the skill levels of the local engineers and scientists in the different R&D units are shown. Within Mechanic Tech, Chinese engineers were described by Scandinavian R&D managers as being superior to the Scandinavian engineers, e.g. concerning development of circuit cards. This is a type of activity which requires good technical understanding – which can be interpreted as good codification skills.

	Mechanic Tech (China + India)	Wind Tech (India)	Med Tech (China)
Codification skills	China: Superior India: Very good Very good training program for new recruits	Very good	Very good
Socialization skills	China: Things can be good enough, which is a new R&D worldview in the company	Collaboration across different specializations in India as opposed to within specialization collaboration in Scandinavia New mindsets	New perspectives on conducted experiments
Type of innovation activity	Product adaptations to the Asian market	Process innovations Product innovations improving performance of products Virtual test systems, which speed up new product development Product innovations lowering logistics costs	Process innovation, e.g. leading to a productivity increase in the protein processes of the company

Source: Case data

Table III. Contributions to innovation performance in China and India

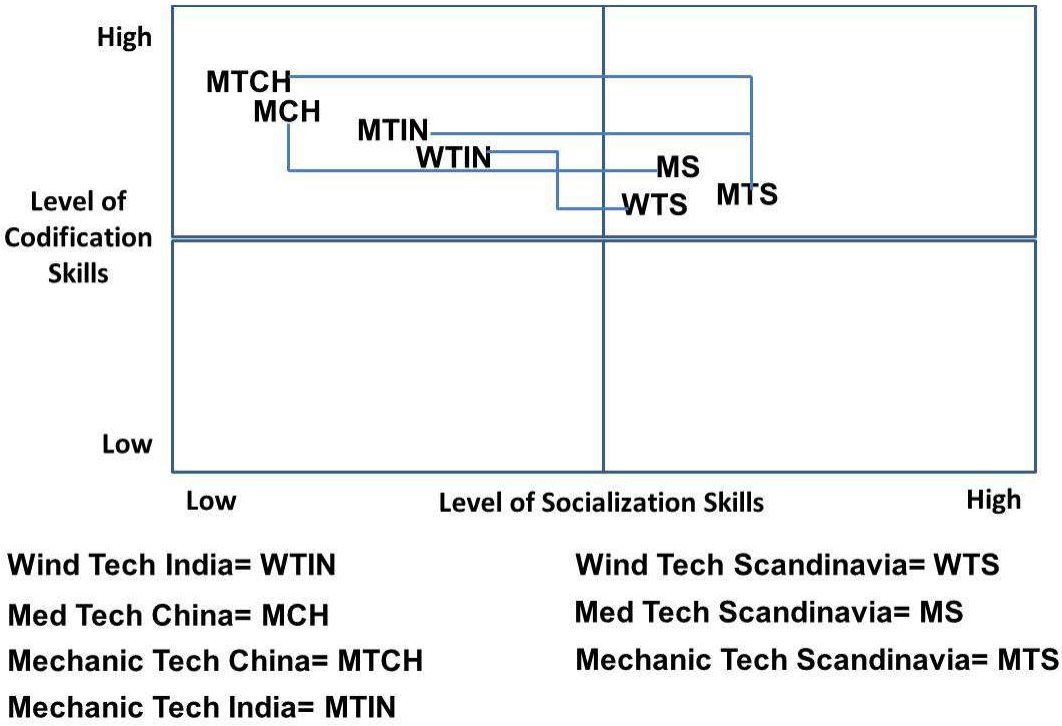

Figure 2. Skill evaluation within the case companies, across the different R&D units

Within Wind Tech, the Scandinavian engineers emphasized the good theoretical understanding of the Indian engineers. The Indian engineers had also come up with several process-oriented innovations, such as the disintegrated manufacturing process, which makes it relevant to plot the engineers in the newly established R&D unit in India as having good codification skills. However, the Scandinavian engineers also experienced problems, in terms of getting the Indian engineers to take the social initiative with the purpose of knowledge creation and transfer. This makes it relevant to plot the Indian R&D unit as lower in terms of socialization skills. They did, however, establish an innovation group which includes people from different parts of the Indian R&D unit. Therefore, they are plotted higher on the socialization dimension than the other newly established R&D units in China and India.

Across the different case companies, the Scandinavian engineers perceive themselves as being good at taking the social initiative, with the purpose of knowledge creation and knowledge transfer. This picture is largely supported by their colleagues in the newly established R&D units in China and India. However, of the Scandinavian R&D units in this multiple case study, the Scandinavian R&D unit of Wind Tech has been plotted as having the weakest socialization skills due to the tendency to collaborate only with people from the same specialized group. This was noticed by engineers working within the Indian R&D unit of Wind Tech.

The scientists within Med Tech were able to come up with very significant improvements of processes, which the Scandinavian scientists, within the company, had already been working on, and from which were made codified project protocols. The Chinese scientists within Med Tech are, therefore, plotted as having better codification skills than their Scandinavian colleagues. Within all the case companies there seems to be a problem in terms of getting engineers and scientists to take the initiative, etc. within the newly established R&D units in China and India.

The socialization skills are, therefore, generally plotted as being lower than they are for the Scandinavian scientists and engineers in the case companies examined.

5. Implications

5.1 Managerial implications

The framework outlined in this paper can inform decisions concerning how to deal with knowledge creation shortcomings in organizations.

Complementary R&D skills seem to exist between Scandinavia, China, and India. This can be exploited by MNCs, since the engineers in both China and India seem to have very good technical codification skills, which are sometimes superior to engineers in Scandinavia.

China, as well as India, is likely to excel in relation to the creation of innovations, which require good codification skills, and where the problem solved by the innovation is less socially embedded. To focus on things where large benefits are likely to be obtained by applying sophisticated existing technology, to existing problems in new ways, may be a good innovation strategy for emerging markets such as China and India. Such innovations may often be of a process-oriented nature.

Also the cases make clear that foreign-invested R&D in China and India benefit from good interaction with more experienced R&D units within MNCs. This may be particularly beneficial in terms of overcoming knowledge gaps.

5.2 Implications for further research

Process innovation seems to be the common denominator of the innovations presented in these case studies. Harryson et al. (2008) hypothesized that process-oriented industries are less dependent on proximity. To some extent, their hypothesis is supported by the research presented in this paper, since the innovations presented in this paper take place in R&D organizations, which are global. Further research may improve our understanding of this subject.

Further research might look at the relationships between codification skills, socialization skills, and the absorptive capacity of organizations (Cohen and Levinthal, 1990; Zahra and George, 2002; Lane and Lubatkin, 1998) and the effects on innovation performance across country datasets.

6. Conclusions

Social interaction nurtures knowledge creation, and especially the transfer of tacit knowledge (Johnson, 2007; Nonaka and Konno, 1998). Weak socialization skills may impede transfer of tacit knowledge, within newly established foreign invested R&D units in emerging markets. The developed framework, built primarily on knowledge creation theory, was illustrated by three cases of newly established foreign invested R&D units in China and India. The cases show that barriers for innovation exist in China, India, and Scandinavia. The availability of good codification skills are likely to be important in terms of understanding why impressive innovations are made in China and India, in spite of the outlined barriers. Innovative efforts depending on good codification skills (e.g. having a process innovation focus) is a viable way for newly established foreign invested R&D units in emerging markets to contribute to innovation performance within MNCs.

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