**LEARNING-BY-DOING IN EMERGING MARKET MULTINATIONALS:**

**INTEGRATION, TRIAL AND ERROR, REPETITION, AND EXTENSION**

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**Abstract**

We analyze learning-by-doing and how emerging market multinationals use it to upgrade their capabilities. Building on an in-depth case study, we present two novel arguments. First, we clarify the concept of learning-by-doing by identifying four distinct processes in which learning-by-doing occurs: Integration, whereby the firm incorporates external knowledge and coordinates multiple sources of knowledge to undertake an activity; trial and error, whereby the firm attempts a new activity until it succeeds; repetition, whereby the firm improves the activity by undertaking it multiple times; and extension, whereby the firm takes on a larger and more complex activity. Second, we extend our understanding of how the country of origin influences firm behavior by explaining how particular characteristics of emerging markets (few specialized providers, relative knowledge isolation, rapid market growth, and increasing consumer sophistication) strengthen the relationships between the four learning-by-doing processes and the upgrading of capabilities to international levels.

**Keywords**: learning-by-doing, capabilities, upgrading, emerging countries, case study, CSCEC

**1. Introduction**

Emerging market multinationals are expanding rapidly around the globe, providing new competition for developed-market multinationals (Banerjee, Prabhu & Chandy, 2015; Cuervo-Cazurra & Genc, 2008; Dawar & Frost, 1999). Although some have become global leaders in their industries, such as the Brazilian meatpacker JBS or the Mexican bakery Bimbo, many still suffer from disadvantages in their ability to create advanced technologies. One reason is that these firms come from emerging countries with weaker innovation systems (Furman, Porter & Stern, 2002; OECD, 2015), limiting their ability to develop sophisticated new products (Awate, Larsen & Mudambi, 2012). To overcome their technological disadvantage, the literature has suggested upgrading capabilities by using external sources of knowledge, for example by copying the more sophisticated technology of advanced country competitors (Chittoor et al., 2009), establishing alliances with advanced country firms at home (Mathews, 2006), or acquiring advanced country competitors abroad (Madhok & Keyhani, 2012).

Complementing these studies of external learning, in this paper we analyze learning-by-doing and explain how emerging market multinationals can use it to upgrade their capabilities. Studies on learning-by-doing tend to argue that cumulative experience enables firms to reduce production cost, improve quality, and innovate more (e.g., Argote, 1999; Argote, Beckman & Epple, 1990; Arrow, 1962; Jain, 2013). However, they rarely examine the processes by which this learning occurs (e.g., Adler & Clark, 1991; Macher & Mowery, 2003). Hence, to answer our “how” research question and extend the literature on learning-by-doing, we conduct a case study (Yin, 2008). Specifically, we analyze how the Chinese construction firm China State Construction Engineering Corporation (CSCEC) upgraded capabilities to become the largest construction company in the world, when just a decade before it was not even in the top ten (Economist, 2012).

The case study reveals two novel insights that contribute to two strands of the literature. First, we identify four distinct processes in which learning-by-doing occurs: Integration, whereby the firm incorporates external knowledge and coordinates multiple sources of knowledge to undertake an activity; trial and error, whereby the firm attempts a new activity until it succeeds; repetition, whereby the firm improves the activity by undertaking it multiple times; and extension, whereby the firm upgrades its capabilities as it takes on a larger and more complex activity.

These four processes contribute to the organizational learning literature (for reviews see the chapters in Dierkes et al., 2003) and the concept of learning-by-doing (see a review in Thompson, 2010) by identifying the little-analyzed processes underlying learning-by-doing. Much of the literature on learning-by-doing assumes that firms benefit from learning-by-doing, based on the observation that costs drop with increases in output, but the literature does not directly analyze and explain the mechanisms (Thompson, 2010). Some studies even argue that learning-by-doing is mostly the result of the application of better technology and more capital rather than learning by employees (Thompson, 2001). In contrast to these ideas and complementing other process studies (Macher & Mowery, 2003), we explain the processes behind learning-by-doing and identify four processes that reflect employee as well as company learning and improvement. These processes go beyond the commonly-held and narrow view of learning-by-doing as being limited to the repetition of an activity; the processes have distinct learning characteristics that can be used by managers as they face various learning challenges.

Second, we propose that the conditions of the country of origin influence learning-by-doing. Specifically, we explain how particular characteristics of emerging markets –fewer specialized providers, relative knowledge isolation, rapid market growth, and increasing consumer sophistication– strengthen the relationships between the four learning-by-doing processes and the upgrading of capabilities.

These ideas contribute to the theory of the multinational and emerging market multinationals (for reviews see the chapters in Cuervo-Cazurra and Ramamurti, 2014) by providing new insights on how the country of origin affects a firms’ behavior. The usual argument is that managers learn how to operate under the weak institutional conditions that tend to characterize emerging countries and use this learning abroad by investing in other countries with similar conditions (Holburn & Zelner, 2010). Instead, we argue not only that what is learned in emerging markets differs, but also that how this learning is achieved differs as well. Thus, studying firms in emerging markets can be the basis for new theoretical insights on learning that cannot be achieved by analyzing advanced economy firms, helping advance the theory of the multinationals.

The paper also has important managerial implications. We explain how managers of emerging market firms can use four separate learning-by-doing processes to upgrade the capabilities of their firms, thus helping them achieve technological leadership, which may not be achieved by just integrating external knowledge (Chittoor et al., 2009; Luo and Tung, 2007; Madhok & Keyhani, 2012; Mathews, 2006). We also explain how, despite the weaker technological infrastructure typical of emerging markets, managers can nevertheless take advantage of some of the characteristics of their countries to strengthen the upgrading of capabilities via learning-by-doing, therefore providing recommendations that are more appropriate for the conditions of their companies.

**2. Previous Literature: Learning-by-Doing, Capability Upgrading, and Emerging Market Firms**

We now discuss the key concepts of the study and prior literature on learning-by-doing in emerging markets to justify the use of a case study. We start with a brief review of the relationship between learning-by-doing and capability upgrading, and then move to a discussion of capability upgrading in emerging-market multinationals.

*2.1. Learning-by-doing and capability upgrading*

Learning and capabilities are interdependent. Learning is the process by which a firm creates new knowledge to solve specific operating challenges to improve efficiency and output quality (e.g., Macher & Mowery, 2003), while capabilities are the abilities to coordinate and disseminate new knowledge company-wide to increase competitiveness by increasing efficiency and innovation (Bartlett, Ghoshal & Beamish, 2008). Thus, learning focuses on creating new knowledge to solve operating challenges, while capabilities are used to coordinate and disseminate that new knowledge firm-wide to increase firm performance.

The literature discusses two paths linking learning and capability upgrading, one that focuses on external learning and another that focuses on internal learning. First, some studies argue that firms learn and upgrade capabilities by acquiring external knowledge already created by other firms. Firms can form alliances with companies that possess superior knowledge, acquire firms with the desired knowledge and technologies, or license or copy another firm’s knowledge and technologies (e.g., Liu, Ghauri & Sinkovics, 2010; Lou, Sun & Wang, 2012; Muehlfeld, Sahib & van Witteloostuijn, 2012; Wang, Roijakkers & Vanhaverbeke, 2013). Second, other studies argue that firms primarily learn and develop capabilities internally, accumulating their own experience (Cohen & Levinthal, 1990; Levinthal & March, 1993; for a review, see Weigelt, 2009).

In this study, we focus on internal learning and specifically on learning-by-doing. We define learning-by-doing as the processes by which firms create new knowledge by solving their own operating challenges in ways that result in improved firm performance in terms of efficiency and product quality. Learning-by-doing is used to explain how firms improve capabilities and become more efficient over time (for reviews of the concepts see Yelle, 1979, Dutton & Thomas, 1984; and Thompson, 2010) as well as how they improve product quality, although the latter has received less attention (Levitt, List & Syverson, 2013).

The original insight came from the observation that the number of man-hours used to produce an airplane decreased with every doubling of the units produced (Wright, 1936). The explanations that this and other studies provide for the reduction in costs with the doubling of output include the reduction of waste in motion and actions, and individual learning with the repetition of activities (Adler & Clark, 1991; Argote & Epple, 1990; Dutton & Thomas, 1984). Employees learn over time to become more efficient in their tasks and, as a result, the costs of producing additional units of a product diminish as production numbers accumulate. Additionally, learning-by-doing results in higher efficiency as firms increase product quality by reducing defects (Levitt et al., 2013). Learning occurs through the acquisition of knowledge in an attempt to solve a problem in an activity (Arrow, 1962). The idea of learning-by-doing has been used to explain increases in production efficiency in manufacturing settings, such as the Toyota Production System (Ohno, 1998), as well as to explain other firm behavior such as alliances (Tsang, 2002), mergers and acquisitions (Collins et al., 2009), and subcontracting (Gil & Marion, 2009). Learning-by-doing differs from economies of scale or scope, in which costs are reduced as the firm produces a higher number of units in a period of time; in these cases the cost reduction comes from spreading fixed costs among a higher number of units.

However, there is a debate about the specific mechanisms by which firms achieve cost reduction and quality improvement in learning-by-doing (Hall & Howell, 1985; Levitt et al., 2013). On the on hand, in most studies, the learning process and the specific mechanisms are assumed rather than analyzed; studies look at the accumulation of units and the cost of such accumulation first, and then argue that learning has happened (Balasubramanian & Lieberman 2010, 2011; Sutton 1998). Studies find differences in rates of learning-by-doing within the organization, such as across shifts in a production plant (Argote, Beckman & Epple, 1990; Epple, Argote & Devadas, 1991; Levitt et al., 2013), and across industries (Balasubramanian & Lieberman, 2010). On the other hand, some authors argue that the reduction in costs comes from the increase in capital employed or in the R&D activities that generate innovations, rather than from employees learning as units accumulate (Thompson, 2001). Others propose that the variations in rates of improvement originate from differences in R&D investment rather than from differences in learning-by-doing (Sinclair, Klepper & Cohen, 2000).

Therefore, the debate seems to reflect two broad streams of research on learning-by-doing. The first focuses on the cumulative experience of doing the same activity and the subsequent performance. The more experience individuals or firms accumulate, the more it is assumed they have learned, since there are performance improvements in quantity, quality, or costs (for a review, see Jain, 2013). This stream of the literature tends not to examine the processes by which cumulative experiences enable performance improvements (Thomson, 2010). The second stream studies internal processes leading to learning-by-doing. Learning-by-doing is stimulated by operating challenges as firms take deliberate actions to find solutions to problems. Thus, in learning-by-doing a firm faces a challenge, searches for knowledge, creates solutions, and disseminates them to solve similar challenges, thereby increasing efficiency and reducing costs (Hatch & Mowery, 1998; Macher & Mowery, 2003). We follow this second tradition and go deeper into the processes underlying learning-by-doing, particularly in emerging market firms.

*2.2. Learning-by-doing in emerging market multinationals*

Emerging and advanced economy firms are likely to upgrade capabilities differently, because of the differences in innovation systems in their home countries (Allard, Martinez & Williams, 2012; Cantwell & Mudambi, 2005; Furman et al., 2002; Hu & Mathews, 2005; Nelson, 1993). Table 1 summarizes these differences in national innovation systems. Emerging market firms come from countries with weaker innovation systems, characterized by lower investments in public R&D, lower openness to international trade and investment, lower protection of intellectual property protection, fewer skilled employees, lower private investment in R&D, and weaker relationships between firms and universities (OECD, 2015). As a result, emerging market firms tend to be less able to rely on their home-country environment for advanced technologies and tend to be less innovative than advanced economy firms (Furman et al., 2002; Hu & Mathews, 2005).

\*\*\* Insert Table 1 about here \*\*\*

Because of the relatively weaker innovation systems of emerging markets, studies tend to suggest that to overcome their backwardness and upgrade their capabilities to international levels, emerging market multinationals should learn from advanced economy competitors. There are several ways to do this. One way is to rely on the knowledge of advanced economy firms by forming alliances with their subsidiaries operating in the emerging country and acquiring advanced knowledge and technologies from these firms by becoming part of their global supply and distribution chains (Kumaraswamy et al., 2012; Matthews, 2006). Another way is to acquire firms in advanced economies to obtain their superior knowledge and technologies (Luo & Tung, 2007; Madhok & Keyhani, 2012; Rui & Yip, 2008). Yet another way is to copy what the advanced economy firms have done, taking advantage of the lower protection of intellectual property common in emerging countries (Chittoor et al., 2009; Luo, Sun & Wang, 2011).

In line with these arguments, many studies of emerging market multinationals tend to focus on their reliance on foreign firms for learning and capability upgrading (e.g., Aybar & Ficici, 2009; Buckley, 2009; Deng, 2009; Gubbi et al., 2010; Hope, Thomas & Vyas, 2011; Kafouros & Forsans, 2012; Kumaraswamy et al., 2012; McDermott & Corredoira, 2010; Stucchi, 2012; Thomas et al., 2007; Zhan & Luo, 2008), paying relatively less attention to the internal processes that emerging market firms may use to upgrade their capabilities to international levels. However, firms can rarely create a sustainable competitive advantage by relying on external knowledge alone (Barney, 1986; Cohen & Levinthal, 1990; Prahalad & Hamel, 1990). Although external learning methods enable emerging market multinationals to gain knowledge, especially explicit knowledge, these do not necessarily enable them to gain tacit knowledge and the complementary resources that create such knowledge. Therefore, it is important to understand the processes by which emerging market multinationals learn internally and upgrade their capabilities.

To better understand internal learning, particularly learning-by-doing, and capability upgrading by emerging market multinationals, we undertake a case study (Yin, 2008). The case study enables us to go deep into the firm and study the mechanisms that underlie learning and innovation (Bartlett & Ghoshal, 2000). This follows the tradition of other studies on capability upgrading in emerging market multinationals, which have discussed how some of these firms have been able to reach the technological frontier by investing in R&D (Bromfield & Barnard, 2011), or by generating increasingly better products even if they have yet to reach the sophistication of those created by advanced economy competitors (Awate, Larsen & Mudambi, 2012).

**3. Research Design**

We analyze the transformation of the Chinese construction firm CSCEC from a collection of domestic firms in the 1950s into the largest construction multinational in the world by the 2010s. CSCEC was incorporated in 1982 by integrating eight bureaus (the name given to companies under the planned economy, which some firms still use) in China and a dozen companies dedicated to overseas business or specializing in design, decoration, and services, which had been created in the 1950s. By 2014, CSCEC ranked52 in the Fortune Global 500, had sales of US$110.8bn (Fortune, 2015), and was the largest construction company in the world (Economist, 2012).

Following Eisenhardt & Graebner (2007) and Yin (2008), two reasons explain the selection of this case as a laboratory for identifying learning-by-doing processes that enable an emerging market firm to upgrade its capabilities and become a leading multinational. First, it was denied learning from foreign firms in the 1950s to 1970s when China was under first sanctions and then isolation. It was then exposed to direct foreign competition in the 1980s because the construction industry was among the first to be liberalized, forcing it to upgrade its capabilities to survive. Second, unlike firms in other industries –such as automobiles or computers– it did not form large international joint ventures at home or acquire foreign firms abroad to obtain technology. Thus, much of CSCEC’s knowledge came via internal development, with learning-by-doing playing a large role (Liu, 1994).

*3.1. Data collection*

We collected data using documents, field observations, and interviews. First, we collected approximately 1,100 pages of documents from corporate annual reports, web sites, speeches by the CEO and top managers, magazines published by CSCEC and by China’s International Engineering Contract Business Association, books, and newspaper articles both in Chinese and in English, including the Financial Times. Using multiple sources of data was important for understanding the evolution of the firm, especially in its early development because few participants from that time were available for interviews.

Second, we conducted 18 field trips between 2009 and 2014. At each site, we listened to the project managers’ explanations of the projects, observed the results of on-going projects, and asked questions about key technical and managerial challenges and their solutions. We also talked to workers regarding their work and living experiences, and asked about how they ensured speed and quality in completing the projects. After years of observing and questioning, we obtained tacit knowledge on how a project is managed and how it progresses from the perspective of managers and frontline workers.

Third, we conducted 31 semi-structured interviews, starting with the CEO, the deputy CEO (who is also the CEO of the Department of Overseas Business), and subsidiary heads and project managers of the main overseas markets. Table 2 summarizes the interviews. We promised interviewees anonymity except for their positions. We accessed these interviewees with the help of the Chinese commercial council or directly by calling their offices in the host country. Overseas subsidiary interviewees gave access to other interviewees located in other subsidiaries.

Questions were designed differently for each interviewee to benefit from their specific knowledge. The interviews covered topics that included: (1) the company’s evolution, milestones, strategy, and structure; (2) participation in large domestic projects, international aid projects, contract projects, and investment projects; as well as how these activities facilitated capability upgrading; (3) the competitive advantages and disadvantages of CSCEC in construction design, engineering, quality, and cost and project management in comparison to competitors at home and abroad; (4) how the firm upgraded its technological and managerial capabilities via direct and indirect methods; (5) the mechanisms through which the parent and subsidiaries shared and transferred technological and managerial knowledge; and (6) the advantages and disadvantages of CSCEC in learning as a large state-owned firm and as a construction firm. To ensure triangulation, we also interviewed Chinese commercial councilors and ambassadors in the host country, host government officials, customers, and even the general public. Using multiple sources of data helped check for data reliability. This enabled us to achieve construct validity since different sources of evidence provided multiple views of the same phenomenon. Documents were essential for understanding the early stages, while interviews and observations were more effective for understanding the current situation.

\*\*\* Insert Table 2 about here \*\*\*

*3.2. Data analysis*

We used the case study methodology to understand how and why the firm took particular actions (e.g., Eisenhardt, 1989; Yin, 2008), and analyzed data using five steps. First, we identified the evolution of CSCEC. We read data from multiple sources, made ourselves familiar with the details, and constructed a case study in which we gained an understanding of the company’s knowledge development. We established a chronological map of events, documenting the actions and activities of the firm over time. Table 3 summarizes the key events in the company’s history. We attempted to understand CSCEC’s major learning actions, outcomes, and their relationships. With this information, we identified chronological steps in CSCEC’s learning activity and knowledge upgrading. The separation of steps was based on changes in the learning objectives and environment. As we obtained additional data, we added them to the case until we reached saturation, with additional documents and interviews confirming previous events and yielding fewer new insights.

Second, we examined the determinants of capability upgrading. With the analysis of the data, we started to gain an understanding of the determinants of CSCEC’s capability upgrading. We contrasted the case with existing theoretical arguments, examining the underlying themes contributing to capability upgrading. By checking the frequency of claims, we obtained the following determinants identified by interviewees: corporate history as a conglomerate, large number of projects undertaken, participation in landmark projects at home and abroad, talent, R&D, hard work and practice, competitive market, leadership, ownership, and government support. Because we interviewed employees on a continuous basis since 2009, after identifying frequent determinants we asked later interviewees to evaluate the validity of the determinants, discussing more fundamental causes. In parallel, we cross-checked the validity of these key determinants against documentation and observation data.

Third, we identified unique practices in CSCEC’s capability upgrading. We attempted to understand which determinants of capability upgrading were more fundamental or unique to CSCEC. To achieve this, we compared CSCEC to other Chinese MNEs and construction firms. We discovered that CSCEC never thought of making large international joint ventures (IJVs) or foreign acquisitions as an important mechanism for upgrading capabilities, although interviewees did mention the positive impact of the occasional interaction with foreign firms. This showed a striking difference from firms in other industries in which IJVs were common. CSCEC interviewees emphasized the large number of projects undertaken on their own and were proud of their organic learning. By then, the concept of learning-by-doing emerged.

Fourth, we identified the constructs and causes of learning-by-doing. We gained an understanding of learning-by-doing based on studying the unique processes of CSCEC and the existing literature on learning-by-doing and capability upgrading. After realizing that existing literature on learning-by-doing had rarely focused on learning-by-doing processes, the main focus of our analysis became understanding these processes. We asked for comments from later interviewees and reviewed earlier data to identify additional evidence for and against these learning-by-doing processes.

Finally, we refined our understanding of the processes of learning-by-doing by reassessing the case and ideas against existing arguments, refining and drawing conclusions that speak directly to theory. By then we were able to explain what drove the capability upgrading process of CSCEC, how it was done, and why.

\*\*\* Insert Table 3 about here \*\*\*

**4. Theory Development: Capability Upgrading via Learning-By-Doing in Emerging Market Firms**

The analysis of CSCEC helps us better understand the processes that facilitate the upgrading of capabilities via learning-by-doing. We identified four learning-by-doing processes: integration, trial and error, repetition, and extension. Table 4 summarizes their characteristics and provides representative quotes.

\*\*\* Insert Table 4 about here \*\*\*

The analysis yields a theoretical framework illustrated in Figure 1. The figure presents the direct relationships between the four learning-by-doing mechanisms and capability upgrading, and how these relationships are modified by particular characteristics of emerging markets: fewer specialized providers, higher knowledge isolation, higher market growth, and increasing consumer sophistication. We focus on these particular characteristics of emerging markets because they represent environmental conditions that induce firms to more intensively use the learning processes to upgrade capabilities: having fewer specialized resources induces firms to use integration more intensively because firms are less able to rely on external providers of knowledge; having higher knowledge isolation forces firms to rely on trial and error more often to address challenges as there are fewer ready-made solutions easily available; having higher market growth induces firms to undertake repetition with more frequency because there are additional opportunities to engage in it; and having increasing consumer sophistication induces firms to engage in extension more often to be able to provide more sophisticated products and services.

\*\*\* Insert Figure 1 about here \*\*\*

*4.1. Integration*

The first learning-by-doing process is integration, whereby the firm incorporates sources of knowledge and creates new practices as it undertakes an activity. In integration, the company learns as it creates complementarities and synergies among the integrated knowledge. Integration is more than the aggregation of external knowledge which resides in multiple sources; it requires coordination among the sources of knowledge to facilitate their interactions. The activity provides a focal point to induce the different sources to collaborate and facilitate the exchange of their knowledge, leading to the creation of practices that facilitate such interactions. By providing an activity that can be measured, the different sources create integrative mechanisms that facilitate their interactions, and by establishing the need to perform well in the activity, the different sources improve their own capabilities as they learn from the knowledge of other sources and from their interactions with these sources. Learning occurs as employees develop an understanding of how to operate in and undertake activities as a company (Crossan, Lane & White, 1999). This learning is informally held in the mind of employees, who gain new skills and learn how to interact with other employees, establishing practices and procedures that facilitate interactions and the undertaking of activities. This knowledge can then be formally established in manuals that are created to recollect the learning gained. In integration, cost reduction and quality improvement come from the reduction in uncertainty regarding the skills and abilities of employees and their work and reliability. One outcome of this process is the creation of a corporate culture for operating, which can be the basis for an advantage later on (Barney, 1986). Thus, integration is a discontinuous process whereby the firm learns as it incorporates new sources of knowledge and builds bridges among them; if the managers decide to limit the incorporation of new sources of knowledge, the integration process also slows down.

One example of how this learning-by-doing process works is the building of the factory for the First Automobile Works (FAW) by the First Bureau, one of the antecedents of CSCEC. In 1953, the First Bureau lacked the technological, engineering, and managerial capability as well as the construction documentation to handle a project so unprecedented in size and complexity in the history of the Chinese automobile and construction industries. “The construction was made mainly manually; a few crane and tipper vehicles were the main mechanical on site. … For the technologies we did not understand, we learned by doing. Whatever a job was required, we learned it” (First Bureau, 2013). Managers and technicians lacked experience and were asked to learn and master new technologies as quickly as possible and they did this by incorporating knowledge available throughout the country. “Our company soon gathered volunteers across the country, including veterans, professional engineers from the army, college graduates, and skillful mechanics from big cities…. University professors came to train our workers” (First Bureau, 2013). One civil engineer, Wu Shihe, had worked earlier in a Shanghai firm familiar with both Western and Chinese construction processes, and thus guided the company to adopt some Soviet factorization and mechanization methods. The company creatively pre-made various components and shipped them to the construction site for installation to maximize the use of labor and speed up the process. The company established a quality control team, as well as rules and criteria to ensure construction quality (Zhang, Zhang & Yao, 2004).

The experiences of integrating knowledge and overcoming technical and engineering challenges were shared inside and outside the company through publications and conferences. In 1953, the Ministry of Construction (MCI) used the FAW construction site as a training base and transferred more than a hundred minister-level cadres, managers, and technicians from all over China to study while working there. Professors were invited to hold lectures and seminars to the cadres and managers (Zhang, 2012). A year after the construction work, the First Bureau asked managers of all levels to summarize their experiences, which became the *Collection of Construction Project Management*,the*Data Collection of Construction Technology*, and *The Managerial Experience of FAW Construction* (Wu, 1956). The State Council held a national conference where the top manager of the First Bureau reported on the construction experience, initiating a nationwide implementation of scientific management in construction projects (Zhang, 2012).

A similar process happened during the actual creation of the CSCEC in 1982. With the opening and gradual liberalization of the economy in 1978, the government created CSCEC by integrating eight bureaus established since the 1950s. CSCEC instantly became the leader in building “high, large, excellent, and cutting edge” projects in China’s construction industry. It then undertook a deep corporate restructuring to enhance the integration of knowledge and learning. “Headquarters decided an overall plan for the group companies. Subsidiaries were only allowed to make bids in host countries that had been agreed upon by the headquarters. They were requested to share their experiences and cooperate on projects and not to initiate any infighting among the subsidiaries. This new corporate policy greatly reduced internal competition and enhanced learning among its affiliated bureaus and overseas subsidiaries” (Deputy project manager of St. Petersburg project, 2010). Once internal competition was reduced, “CSCEC created an effective system and corporate culture to maximize the benefits from its capabilities scattered in subsidiaries. One way of doing this was to continuously implement standardization and institutionalization of knowledge sharing and learning” (CEO of CSCEC, 2012).

We summarize these ideas in the following proposition:

*Proposition 1a. The integration and creation of connections among a wide variety of sources of knowledge in an activity is positively related to the upgrading of capabilities via learning-by-doing.*

Operating in an emerging market strengthens this relationship because integration helps to compensate for the limited availability of sophisticated specialists that could provide the firm with ready-to-use knowledge. In advanced economies there are well-developed intermediaries and providers of sophisticated knowledge and technology (Khanna & Palepu, 2010) and good protections for property rights (Zhao, 2006), which facilitate the integration of external knowledge. A firm that is in need of some expertise or knowledge can easily find a provider and contract such provision. In contrast, in emerging countries such providers are not as sophisticated or available, and contracting is inefficient (Djankov et al., 2002; Khanna & Palepu, 2010). As a result, a company in an emerging market has to integrate more knowledge via its employees and rely less on specialized suppliers, with employees acting as broad generalists that can later become specialized. The firm facilitates the integration and coordination of the knowledge of employees and external providers given that it cannot rely on existing expertise and knowledge because they are less specialized than in advanced economies. This does not mean that emerging market companies will have more sophisticated technologies than advanced economy competitors who can rely on highly specialized and sophisticated providers of knowledge. It only means that learning-by-doing via integration has a higher impact on capability upgrading in emerging market multinationals because the sources of knowledge experience a higher degree of transformation within the company.

Integration was used by CSCEC both at home and abroad to deal with and also exploit the institutional voids. For example, during the early stage of building the FAW, CSCEC used masses of employees to learn from integration because it lacked expertise in building an automobile factory. At the same time, it took advantage of a situation in which companies had limited legal recourse to prevent their employees and knowledge from being taken away. CSCEC was able to gather volunteers from across the country to help the project, including the talented Wu Shihe who shared his knowledge on factorization and mechanization methods without requiring compensation (First Bureau, 2013).

When going overseas to do aid projects in the 1950s and contract projects in the 1980s, the company made extensive use of expatriates to reduce cost and learn and share more effectively, moving expatriates around from headquarters to subsidiaries and across subsidiaries. “The company did not have any experience to deal with international market and the government did not have ready [regulatory, legal, commercial] documentations for us to learn before going to international market” (Deputy CEO of CSCEC, 2011). For example, when South Pacific was established in Singapore in 1991, Chen Guocai was ordered to head South Pacific because he was among the few who had already had some international market experience after working in Kuwait and Iraq and visiting the US subsidiary. When he needed more people, he selected the best among those who had worked in high profile projects at home, such as Ye Xinxiang and Yu Tao, and trained them by implementing projects in Singapore.

We summarize these ideas in the following proposition:

*Proposition 1b. The positive impact of the integration of a wider variety of sources of knowledge in activities on the upgrading of capabilities via learning-by-doing is strengthened in emerging markets with relatively fewer specialized knowledge providers.*

*4.2. Trial and Error*

The second learning-by-doing process is trial and error, whereby the firm attempts a new activity until it succeeds. In the trial and error process, the focus is on experimentation and on solving a particular challenge in the activity, which requires the establishment of practices and procedures that overcome the particular obstacle. In trial and error, employees try multiple actions to find a solution to a problem. The challenge of the activity and the need to achieve success focuses the mind of employees towards finding solutions for the problem. Once employees have found a solution and they accept it as appropriate, the solution becomes part of the repertoire of actions that can be used in the future when facing similar problems. The increased efficiency and innovation that accompany trial and error come from experimentation. Solutions to problems are typically derived from experimentation. The problems solved generate solutions that are then applied to similar problems without needing to reevaluate the conditions of the problem, in a process similar to the creation of standard operating procedures (Cyert & March, 1963; March & Simon, 1958). This process is useful for establishing the basis for future improvements, maintaining a balance between finding solutions appropriate for the problem at hand while at the same time generating ideas and solutions that are generic enough to be applied to other problems without having to undertake a full analysis for each problem (von Hippel & Tyre, 1998).

In trial and error, employees learn by finding solutions to the challenges in the activity. However, learning arises not only from finding a solution to the problem, but also from the actions and activities that were unsuccessful. In the process of looking for the best and most appropriate solution, employees try different options, some of which may not be successful or may not be deemed as efficient for the company. These failed solutions are nevertheless a useful source of knowledge and learning for employees, who gain the knowledge of experimentation. When confronted with similar situations in the future, employees who have undertaken trial and error will know which particular courses of action were unsuccessful and thus will not attempt them again, increasing efficiency in the decision making process and the actions taken by the company. To promote company-wide learning, the lessons can be crystalized in reports and manuals that summarize experiences. Thus, trial and error becomes a discontinuous process that the company is likely to use when confronted with new situations. However, if the company is exposed to new situations repeatedly, for example because there are quick technological changes, it may engage in trial and error to the point that it becomes a semi-continuous process.

One example of trial and error was the Tanzania and Zambia railway (1967-1976). To deal with this large international project, the company faced not only the technological challenges of constructing in dangerous geological conditions, but also the managerial challenges of training local employees, coordinating 56,000 Chinese expatriates, and ensuring timely delivery. “There were technical challenges caused by local geological conditions and lack of adequate tools and equipment” (Senior manager of Tazara, 2013). For example, the tunnels section was only about 50 miles long, but it took almost a whole year to finish, while a nearby section spanning 110 miles took only half a year. These tunnels needed to be made in deep mountains without adequate tools and equipment. “The engineering and construction challenges of this section had seemed almost insurmountable. … The work required extensive road building and earthworks, and more construction camps per kilometer than any other section. There were also more casualties here than in other sections” (Monson, 2009, p. 47).

The Chinese had to undertake trial and error in the process in order to find a solution and improve the speed and quality (Senior manager of Tazara, 2013). Eventually, “they guided the teams of workers as they labored to excavate from both ends of each tunnel at the same time, blasting through the rock until they met up in the middle” (Chinese adviser of Tazara, 2013). Managerial challenges were centered on human resource management. Local employees were recruited nationwide. Once recruited, “they were given intensive training in some cases” and the Chinese employees “preferred to teach without words” due to the language barrier: “A [Chinese] technician would assemble and dismantle a piece of machinery and encourage his Tanzanian apprentices to follow until they got the procedure right” (Monson, 2009, p. 44). Cultural challenges also required urgent attention from the Chinese managers, who realized that it was extremely difficult to motivate their Tanzanian apprentices to work as hard as they did. Through this and other aid projects, CSCEC’s predecessors learned to modify technologies to meet local conditions, train local workers, manage expatriates, and organize international logistics. The Chinese improvised processes for training and integrating local employees that bypassed the language barriers, establishing a learning-by-observing system. This was later applied to other projects in African countries that faced a similar language barrier problem. Additionally, “they learned to plan logistical tasks well in advance after suffering from the earlier mistakes on expecting components and material transported from China to arrive on time” (Senior manager of Tazara, 2013). This trial-and-error laid the foundation for CSCEC to win international bidding contracts later.

These ideas lead to the following proposition:

*Proposition 2a. Using trial and error to address and find solutions to new problems in an activity and codifying them is positively related to the upgrading of capabilities via learning-by-doing.*

Operating in emerging markets, in which there is more exclusion of foreign knowledge in part because of the higher degree of government intervention in the economy, strengthens the positive impact of trial and error on capability upgrading, because companies have less exposure to ready-made solutions developed elsewhere that could be applied to the challenges. In many emerging markets, the government plays a very active role in the economy, either for ideological purposes of maintaining control over the economy or for practical reasons of facilitating development (Yergin & Stanislaw, 1998). Additionally, many governments in emerging markets control the economy and protect their domestic companies from foreign products and investors with the belief that such protection is needed for their companies to become stronger by becoming national champions, in a version of the infant industry argument, or due to the desire to reduce dependence on imports and facilitate the industrialization of the country by substituting imports with domestic production (Bruton, 1998). As a result, such countries become partially closed to foreign ideas, products, and investments, limiting the exposure of domestic companies to solutions and ideas developed elsewhere. In such situations, domestic companies that face a challenge have to use trial and error to find their own solution, even if better solutions to the same challenge have already been found abroad.

One example of this process was the trial and error undertaken by CSCEC during the 1950s to 1970s. In the 1950s, China faced an economic sanction by the West, and the Soviet Union was the only country aiding China; that assistance was also withdrawn in the 1960s. China was then isolated from advanced external knowledge until the 1980s, when the open door policy was adopted. This limited the exposure of the firm to the most advanced construction techniques. For example, in 1960, the Sixth Bureau was called by the central government to construct the Daqing Oilfield, which was a crucial part of the “Daqing campaign” (*daqing huizhan*) approved by the central government. According to the then oil minister Yu (1996), the campaign mode was “forced” by the severe situation at that time: “the country urgently needs oil” (Yu 1996). In 1959, total domestic oil production was only 2.05 million tons, while consumption was over 7 million tons; China’s imports of crude oil were constrained by the nation’s limited foreign reserves and the international trade embargo. In the earliest stage the campaign employees did not have accommodations, so they built them with mud and straw; they did not have sufficient food, so they planted corn and vegetables; and they did not have machines to transport their drilling equipment, so they disassembled equipment and transported it by hand. Despite the hardship, in just four years the Sixth Bureau built eight sets of oil refining equipment, more than 40 sets of auxiliary engineering, more than 100 storage tanks, and more than 480 km of process pipelines.

One limitation of trial and error in an emerging market with relative knowledge isolation is that the firm may end up developing what it considers to be efficient and well-known practices, but that are only so within the local context, not the international one. For example, the Japanese company Taisei Corporation showed CSCEC that its methods of operation could be rethought with new practices that achieved higher quality and efficiency. In 1981, the Chinese government approved the construction of the Lubuge Hydropower Station, the first project in China to use international funding and contract management systems. The Taisei Corporation of Japan won the bid. Taisei only sent a management team of around 30 expatriates and employed 424 workers from a Chinese state-owned firm. Its tunnel drilling speed was two to three times faster than that of the Chinese by using a device which enabled the truck to reverse direction without the need to widen the tunnel to maneuver (Zhang, 1997). This project enabled the Chinese construction firms to learn about the international bidding system, project planning, and management. CSCEC headquarters established a dedicated organization to be responsible for learning from the Lubuge experience and required each subsidiary to record how they learned during the project operation. These recorded experiences were shared at the group level and eventually three volumes of the book “Instructions on Project Method Construction” were published in 1997.

These ideas lead to the following proposition:

*Proposition 2b. The positive impact of trial and error to address new problems in activities on the upgrading of capabilities via learning-by-doing is strengthened in emerging markets with higher levels of exclusion of foreign knowledge.*

*4.3. Repetition*

The third learning-by-doing processes is repetition, whereby the firm improves the activity as it repeats it multiple times. Repetition is the usual learning-by-doing process discussed in much of the literature, in which employees learn to do their job better and as a result they need less time to do the same task (Adler & Clark, 1991; Argote & Epple, 1990; Dutton & Thomas, 1984). The repetition of activities over time economizes effort as employees identify the best way to perform the task.

Repetition is a learning-by-doing process whereby employees further improve and refine existing practices and procedures. From repetition, “standards” or “best practices” emerge, which can be adopted by other parts of the firm facing similar operating activities. As employees repeat the activities, they reduce inefficiencies and mistakes and distill the best and most efficient practices; this is the typical view of learning-by-doing in the literature (Thompson, 2010). Learning occurs as employees discern how to perform their tasks better with more experience, reducing waste in actions and effort as they identify and avoid mistakes. It also happens in a guided form as the company analyzes the tasks undertaken and focuses effort on distilling the best practices from those employees that undertake the practices best, and then transferring these best practices to other employees. This is the process underlying most quality improvements (Ohno, 1988), in which the process underlying an activity is dissected and perfected over time as the activity is repeated, reducing the variation in output and the defects incurred. With repetition, the company standardizes the ways in which it is able to complete the tasks in the most effective and efficient way, and applies these methods to other tasks in order to increase efficiency and innovation. Thus, different from the previous two methods, repetition is likely to become a continuous learning process whereby employees learn from performing tasks multiple times and find ways to improve them; although the greater learning and benefits may accrue with the initial repetitions, later repetitions can continue to provide the employees with additional learning and improvement.

A great example of repetition is the increasing speed of construction of the International Trade Centre in Shenzhen. In the early 1980s, the Shenzhen municipal government invited public bids for constructing the International Trade Centre, the highest building in China at the time. The bidding team proposed an innovative sliding mode technique to ensure the speed of the construction and was awarded the contract. However, the sliding mode method had never been tried before in China. The first three trials of the technique failed despite the changes introduced in each trial. Under extreme pressure, the team carefully decomposed the previous failures, identified their causes, and concluded that the filling speed was crucial to success. To solve this problem, the team imported advanced equipment from Europe to improve filling speed. The fourth trial succeeded. As the project team became increasingly familiar with the operation and techniques, the construction speed increased. They spent an average of seven days constructing one floor during the first 5-10 levels, then five days per floor in the 10-20 levels, four days in the 20-30 levels, and three days in the 30-50 levels. The fastest record was 2.5 days for one floor. Since then, “Three Days a Floor” was referred to as “Shenzhen Speed”, which made CSCEC well-known (Mei, 2012).

We summarize these ideas in the following proposition:

*Proposition 3a. The repetition of activities and the associated reduction in defects and identification of best practices is positively related to the upgrading of capabilities via learning-by-doing.*

Operating in an emerging economy strengthens the relationship between repetition and capability upgrading because the rapidly growing market that characterizes emerging economies provides the firm with more opportunities for engaging in repetition and improvement of its practices. Although there is a large variety of emerging markets, one of the defining characteristics proposed is the high growth rates of the economy (Hoskisson et al., 2000); emerging economies can grow at high rates partly because they are starting at lower levels of development and can more easily achieve higher rates of growth with the same levels of investment, and partly because they are undertaking pro-market reforms that facilitate high economic growth. The higher growth rates in the home country provide companies with a booming market in which they can refine and improve their practices by undertaking projects similar to the ones in which they first established their practices.

For example, the booming Chinese construction market that began in the 1980s provided CSCEC with unprecedented business and learning opportunities. The high rates of growth of 8% sustained for over three decades enabled CSCEC to refine and improve techniques as it undertook multiple projects in China. Solutions to challenges found in one location were transferred and improved by applying them in multiple locations, refining them until the company and its workers achieved high levels of competency in construction. For example, since the Third Bureau created its "Shenzhen speed" and developed core competences in constructing tall buildings, it built hundreds more similarly high or ultra-high buildings (Mei, 2012). In terms of speed, for example, in the 1990s it built the Shenzhen Di Wang Commercial Centre with a speed of 2.5 days a floor and the Guangzhou West Tower steel construction with a speed of 2 days a floor, the world's fastest construction speed at the time. In terms of height, it built the 492-meter Shanghai World Financial Center (3 floors in the basement and 101 floors above ground), which was the world's highest building in 2008; and the new CCTV building, the largest single public building. These opportunities in a fast-growing emerging market enabled the Third Bureau to repeat the use of its expertise and improve it; it has won China’s top national construction quality award (Luban National Best Award) 80 times.

We summarize these ideas in the following proposition:

*Proposition 3b. The positive impact of the repetition of activities on the upgrading of capabilities via learning-by-doing is strengthened in emerging markets with higher growth levels.*

*4.4. Extension*

The fourth learning-by-doing process is extension, whereby the firm upgrades capabilities as it takes on larger and more complex activities. Extension entails taking on a larger or more complex new activity that forces employees to modify and expand their skills and capabilities to undertake it. This process forces employees to extend the basis of application of their knowledge, learning new uses for existing practices or modifying existing practices to apply them to new contexts. It enables the firm and its employees to transform and expand their knowledge basis, as they are challenged to stretch beyond the realm of comfort and tackle new challenges. Thus, as the firm undertakes more challenging projects, it can upgrade its knowledge and the skills of its employees closer to the international best practice frontier. The company increases efficiency with the additional projects undertaken as it refines and upgrades its skills and the ability of employees to undertake more complex projects. It also increases efficiency and innovation by passing learning experiences from one employee to another and from one project to another. Thus, this process creates a continuous learning as employees gain new insights from extending the realm of application of their knowledge, which provide them with the basis for stretching and extending their knowledge further.

This process is exemplified by the survey in Iraq, where the team had the knowledge of how to do a survey but had to extend this to address the difficult conditions of operation in Iraq and the lack of adequate instruments. In 1985, CSCEC obtained a contract to conduct a 1:5000 topographic survey, the largest survey contract of the company at that point. Thirty-two CSCEC staff trained themselves for one month before heading to Iraq, but the challenges were still unexpected. As one participant recalled: “The only two PCs we had could only make adjustment calculations but not the drawing work. Therefore, the huge topographic survey work could only be done by hand. To meet the deadline, the team promptly imported four sets of TC2000 Total Station equipment from Switzerland, which was the world’s most advanced equipment at the time. However, another problem emerged: no one was able to use the equipment. … In the shortest time we translated two large volumes of user instructions. With the instructions we tried and experimented, and were able to master the operation technique in two days. The advanced instrument greatly improved mapping speed. Then, a new problem arose. The tender book required the topographic map to be on a 100 by 100 meter grid. But without communication tools such as a walkie-talkie, we had difficulties in mapping accurately. Our technicians searched their brains and ingeniously invented various ‘semaphores’ along an address grid. This sped up the mapping so that we were able to fully meet the specific requirements from the designer” (Wang, 2012).

Based on these ideas, we propose that:

*Proposition 4a. The extension of activities and associated undertaking of more complex activities is positively related to the upgrading of capabilities via learning-by-doing.*

Emerging markets experience a rapid growth in their middle classes, which have increasingly sophisticated demands (Gerth, 2010). The increased sophistication of consumer requirements forces firms to extend into new activities to serve these newly upgraded consumer demands, leading to higher levels of learning-by-doing via extension. The transformation of the economy with pro-market reforms that is common in many emerging countries forces emerging country firms to upgrade their capabilities to be able to compete locally and internationally (Cuervo-Cazurra & Dau, 2009; Kumaraswamy et al., 2012). With pro-market reforms and increases in wealth, consumers become more discerning and demanding, moving up to products of higher quality (Atsmon et al., 2010). By extending, firms can upgrade their capabilities as they undertake new activities, benefitting from a co-evolutionary process (Luo & Rui, 2009). The rapid increase in wealth of consumers modifies their demand for better products, putting pressure on firms to upgrade their offerings.

This increased consumer sophistication is also reflected in the increased sophistication of construction projects, as CSCEC had to upgrade the types of projects it undertook from building basic infrastructure when the needs of the country were lower to making increasingly complex and sophisticated products as the country gained in wealth and sophistication.

For example, the economic development in China brought a rising demand for statement construction projects in China. The China Central Television (CCTV) tower built by CSCEC was one such example. In line with its leading position and dramatically rising income resulting from the general public’s rising entertainment interests, CCTV invited the architects Rem Koolhaas and Ole Scheeren of OMA, well known for designing fancy and peculiar buildings, to design its new tower. The main building was not a traditional tower, but a loop of six horizontal and vertical sections covering 473,000 m2 (5,090,000 sq ft) of floor space, creating an irregular grid on the building's facade with an open center. The construction of the building was considered to be a structural challenge, especially because it was in a seismic zone. The main challenge of the design for the construction was how to build the overhang without the towers buckling under the strain before they were joined, and without using a supporting third tower or lifting a frame from the ground. CSCEC’s engineers had to consider the building's stability at each phase of the construction, and designed a braced tube structure to support the leaning towers during their development before they were connected and balanced off each other. CSCEC worked with the Beijing Municipal Government, who set up a special group with 13 experts from China. The group used a three-story replica building placed on a hydraulic platform to simulate an earthquake, with hundreds of sensors installed to monitor the "tower" on the displacement of more than 10,000 steel beams, measuring in different situations and looking at which parts were most affected by pressure. Innovative methods were developed for the construction, winning 10 patents. The tower was completed in 2012 and praised as “the world-class engineering project” and "construction miracle." CSCEC constructed many such projects to meet the new demands of emerging markets, including the swimming pool stadium that served the 2008 Olympic Games in China, as well as Dubai’s seven star hotels and palm tree projects.

We summarize these ideas in the following proposition:

*Proposition 4b. The positive impact of the extension of activities on the upgrading of capabilities via learning-by-doing is strengthened in emerging markets with increased consumer sophistication.*

**5. Conclusions**

In this study we analyzed learning-by-doing and how emerging market multinationals use it to upgrade their capabilities to international levels. Despite increased interest in how emerging market firms have been able to develop their capabilities to compete at the international level and become multinationals, the question of how these firms accomplish this is still not well understood. Different from other studies that have focused on how emerging market firms rely on the knowledge and technologies of developed-country firms to learn and upgrade capabilities (Contractor et al., 2014; Gubbi et al., 2010; Mathews, 2006; Luo & Tung, 2007), we analyzed how they achieve this internally using learning-by-doing. Learning-by-doing can help the firm achieve a sustainable advantage, because it provides employees with difficult-to-copy tacit knowledge and it is more difficult to observe than other actions thanks to its internal and systemic nature.

To better understand how firms use learning-by-doing, we conducted an in-depth case analysis of CSCEC, the leader in the global construction industry. The analysis results in two novel insights. First, we identified four processes underlying learning-by-doing: integration, trial and error, repetition, and extension. Second, we discussed how these processes are strengthened by particular conditions of emerging markets (few specialized providers, relative knowledge isolation, rapid market growth, and increasing consumer sophistication), explaining how emerging economy firms differ in their learning-by-doing.

The ideas presented here contribute to a better understanding of two streams of literature: to organizational learning and its concept of learning-by-doing by identifying the little-analyzed processes behind learning-by-doing, and to the theory of the multinational and emerging market multinationals by providing new insights on how the country of origin influences firms’ behavior.

First, the identification of four learning-by-doing processes contributes to organizational learning theory by providing a better understanding of the concept of learning-by-doing. Many studies on learning-by-doing tend to assume that learning occurs based on a firm’s cumulative experience (Argote, 1999; Jain, 2013); this is reflected in what we call the repetition process. We build and extend on this narrow view by extending process-oriented learning-by-doing studies (Hatch & Mowery, 1998; Macher & Mowery, 2003; von Hippel & Tyre, 1998) and identifying three additional processes: integration, trial and error, and extension. The identification of these four processes and their distinct characteristics extends our understanding of the concept of learning-by-doing from a narrow focus on repetition to a broader conceptualization which includes several processes that are different but nevertheless reflect the benefit provided by increasing the number of products created by the firm.

The separation among the four processes is important because the processes differ in their learning: Learning emerges from creating complementarities in integration, from finding solutions in trial and error, from avoiding mistakes in repetition, and from stretching the knowledge base in extension. Thus, depending on the particular process the firm is engaging in, and on the intensity of this process, it will gain a different type of knowledge as it repeats the process with the additional number of products created. Moreover, our identification of distinct processes reveals a variation in the continuity of learning. Whereas repetition and extension appear to be more continuous in nature, as they are focused on the refinement of activities, integration and trial and error appear to be more discontinuous in nature, as they are focused on solving particular challenges. Thus, drawing a link to the innovation literature and its discussion of types of innovation, the first two processes may be used to achieve relatively more incremental improvements of activities as they are designed to refine existing actions the firm is taking, while the latter two processes may be used to achieve relatively more radical refinement and improvement of activities as they are geared towards solving new challenges that the firm faces.

Second, the analysis of how particular conditions of emerging markets modify the four learning-by-doing processes contributes to the theory of the multinational by providing a better understanding of the mechanisms linking country conditions and firm behavior. Emerging market firms are achieving competitive parity as well as competitive advantage based on their unique capabilities (Lui & Rui, 2009), and not just the comparative advantage of being in a low-cost country (Rugman, 2010), which advanced economy firms can easily imitate. We explain how the country of origin affects the way in which emerging market firms use learning-by-doing differently. The usual conceptualization of the influence of the country of origin on the behavior of emerging market multinationals is that managers learn how to deal with the poorer conditions of the country and use this learning to achieve an advantage abroad, for example, because they know how to manage under the weak institutions typical of emerging markets and deal with corrupt government officials (Cuervo-Cazurra & Genc, 2008) or manage political risk (Holburn & Zelner, 2010).

Different from this usual conceptualization, we argued that the conditions of emerging markets result in different learning processes; not only what is learned differs, but also how this is learned. Hence, we proposed that the presence of fewer specialized resources leads companies toward more intensive use of integration because firms are less able to rely on external knowledge providers; higher knowledge isolation induces firms to more often use trial and error to address challenges because there are fewer ready-made solutions at their disposal; higher market growth leads companies to undertake more repetition to benefit from the market opportunities; and increasing consumer sophistication leads firms to utilize extension to generate more sophisticated services and products. Thus, this analysis provides the basis for extending theory by analyzing emerging market multinationals and how some of the unique conditions of their country of origin result in differing behavior (Cuervo-Cazurra, 2012).

The ideas in the paper are useful for managers of emerging market firms, because they provide a better understanding of the learning processes and how managers can upgrade the capabilities of their firms through learning-by-doing. Although not all emerging market firms may have the opportunities that CSCEC had to accumulate learning over a long period of time and across many kinds of projects, managers of emerging market firms can maximize the potential effectiveness of integration, trial and error, repetition, and extension in their firms and upgrade capabilities to international levels. These learning-by-doing processes can be deployed to address the changing conditions and opportunities of the environment, as the learning emerges not only from the repetition of the same activity but also from the integration of knowledge, the finding of solutions via trial and error, or the extension of activities. Thus, the conceptualization provided in the paper breaks the assumption that learning-by-doing is available to firms that are able to produce long runs of the same product and repeat the same activities. A company can benefit from learning-by-doing even when it is creating what appear to be very different products or undertaking different activities, as long as managers are conscientious about aiming to gain experience and learning from the activity and transmitting it to others.

The paper has several limitations that can be solved in future research. First, we only focus on one learning method in this study: learning-by-doing. Firms are likely to use other methods at the same time, although they might choose to use some more than others. In the case of CSCEC we found that they used primarily learning-by-doing, although they also incorporated ideas from competitors. Future studies can compare the relative effectiveness of different types of learning approaches, and how diverse methods support learning at different levels of the sophistication of the capabilities of the firm. Second, this is a qualitative study of one successful large company coming from one particular emerging market. Future studies can go deeper into emerging market firms from home countries with varying degrees of development. It is likely that the country of origin of the company influences the preference for certain learning methods over others, as differences in the innovation systems support different sources of innovation and ideas. Third, the company we analyzed operated in the construction industry, which has relatively well-known technology and in which companies tend to compete on the basis of process capabilities. Their learning processes may differ from those of firms operating in high technology industries where product innovation and patents may be sources of advantage. Future studies can analyze how learning-by-doing and capability upgrading operate in industries with different sources of advantage. Finally, the firm we studied was state-owned and thus may have used different learning processes than privately-owned firms, since state-owned enterprises may have different objectives that influence their learning methods and processes.

Despite these limitations, the study provides useful insights to both the literature on learning-by-doing and the literature on capability upgrading in emerging market firms. Future studies can analyze in more detail and test with large samples how particular characteristics of the learning processes of the firm and its country of origin influence the manner in which it upgrades its capabilities.

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Table 1. Differences in learning contexts of emerging and advanced-country firms

|  |  |  |
| --- | --- | --- |
| Dimensions | Advanced countries | Emerging countries |
| **Strength of nation’s innovation infrastructure** | **High** | **Low** |
| Public R&D investment | High | Low |
| Openness to international trade and foreign direct investment | High | Low |
| Intellectual property protection | Strong | Weak |
| Investment in tertiary and secondary education | High | Low |
| Strength of antitrust law | Strong | Weak |
| Number of full-time scientists and engineers/population | High | Low |
| **Environment for industrial clusters** | **High** | **Low** |
| Private R&D funding as a percentage of total R&D funding in the country | High | Low |
| Concentration of innovation activities in certain sectors | High | Low |
| **Quality of linkages** | **High** | **Low** |
| University R&D linked with industry | High | Low |
| Strength of venture capital market | High | Low |
| **Innovation output** | **High** | **Low** |
| International patents | High | Low |

Source: For a comprehensive review, see Hu and Mathews (2005).

Table 2. Information on interviews conducted at CSCEC

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Interviewee** | **Focus of the interview** | **Date**  (dd/mm/yy) | **Venue** | **Length (hour)** |
| Chinese Commercial Counselor, Kenya | CSCEC’s operation in Kenya | 17/06/2009 | Nairobi | 2.0 |
| Chinese Commercial Consul, Russia | CSCEC’s operation in Russia | 16/09/2010 | St Petersburg | 2.0 |
| Representative, Exim Bank China in Russia | CSCEC’s project financing in Russia | 16/09/2010 | St Petersburg | 1.5 |
| Deputy Project Manager, CSCEC St Petersburg Project | The success and failure of the St Petersburg project | 19/09/2010 | St Petersburg | 2.0 |
| President, China St Petersburg Business Association | CSCEC’s operation in Russia & St Petersburg project | 15/09/2010 | St Petersburg | 3.0 |
| Vice President, China Russia Business Association | CSCEC’s operation in Russia & the Moscow project | 24/09/2010 | Moscow | 1.5 |
| Chinese Commercial Counselor, UAE | CSCEC’s operation in UAE | 06/12/2010 | Abu Dhabi | 2.0 |
| CEO, Gong Cheng | CSCEC’s operation in UAE | 07/12/2010 | Abu Dhabi | 2.0 |
| CEO, China Mex | CSCEC’s operation in UAE | 09/12/2010 | Dubai | 1.5 |
| CEO, Far East Consulting Ltd. | CSCEC’s operation in UAE | 09/12/2010 | Dubai | 1.5 |
| Manager of JAFZA, UAE | CSCEC’s operation in UAE | 11/12/2010 | Dubai | 2.0 |
| CEO, CSCEC Middle East (subsidiary) | Overview of the subsidiary | 13/12/2010 | Dubai | 1.0 |
| CEO, CSCEC Middle East | Analysis of the subsidiary | 14/12/2010 | Dubai | 1.5 |
| CEO, Huaian Construction Engineering‘ | Comment on CSCEC as a private competitor | 13/12/2010 | Dubai | 3.0 |
| Welfare Manager, Huaian Construction Engineering, Dubai | Comment on CSCEC as a private competitor | 13/12/2010 | Dubai | 2.0 |
| Official of Ministry of House Construction, China | Analysis of the construction industry and CSCEC | 12/11/2011 | Emails | n/a |
| Head and Deputy Head, Dept. of Enterprise Strategy, China Port | Comment on CSCEC as a SOE competitor | 18/06/2011 | Beijing | 2.5 |
| CEO of CWE | Comment on CSCEC as a SOE competitor | 23/06/2011 | Beijing | 2.0 |
| Chief Manager, Hong Kong Invest | CSCEC operation in Hong Kong | 22/03/2011 | Hong Kong | 2.0 |
| Chen Guocai, Deputy CEO, CSCEC; CEO, Department of Overseas Business, CSCEC | CSCEC’s internationalization process, strategy and capability upgrading | 24/06/2011 | Beijing | 1.5 |
| Guan Qing, CEO, CSCEC | CSCEC’s corporate strategy, structure and capability upgrading | 06/04/2012 | Beijing | 0.7 |
| Head of Marketing, CSCEC | CSCEC’s history, structure, HRM, marketing and organizational learning | 06/04/2012 | Beijing | 2.5 |
| Chief Engineer, CSCEC Middle East | CSCEC operation in UAE | 06/07/2012 | Emails | n.a. |
| CEO, China Construction [South Pacific] Development Co Pte Ltd | CSCEC operation in Singapore | 13/06/2013 | Singapore | 2.0 |
| Deputy CEO, China Construction South Pacific Development Co Pte Ltd | CSCEC operation in Singapore and HRM | 18/06/2013 | Singapore | 3.0 |
| Officer of the Building and Construction Authority, Singapore | CSCEC operation in Singapore and HRM | 05/07/2013 | Emails | n.a. |
| Chinese Commercial Counselor, Singapore | CSCEC operation in Singapore | 18/06/2013 | Singapore | 1.0 |
| Senior Manager, Tazara (The Tanzania Zambia Railway Authority) | How the Chinese managed the construction project | 12/09/2013 | Dar Es Salaam | 1.5 |
| A Tanzanian citizen | How the Chinese managed the construction project | 12/09/2013 | Dar Es Salaam | 1.0 |
| Chinese consultant of Tazara | How the Chinese managed the construction project | 12/09/2013 | Dar Es Salaam | 1.0 |
| Chinese Ambassador, Tanzania | CSCEC in Tanzania and how the railway project | 18/09/2013 | Dar Es Salaam | 1.0 |

Table 3. History of CSCEC

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Stages | | | | | Year | Key events |
| Building a new country (1950s-1970s) | Int’l  aid projects (1950s-2010s) |  |  |  | 1953 | First Bureau created to build the First Automobile Works (FAW).  The Ministry of Construction used the FAW construction site as a training base to train over a hundred minister-level cadres, managers and technicians |
| 1954 | First Bureau summarized managers’ experiences into the Collection of Managing Construction Projects and Data Collection of Construction Technology. |
| 1955 | First Bureau built Fulaerji First Heavy Machinery Plant, applying best practices from FAW and new rules based on the lesson from the FAW construction. |
| 1956 | State Council held a national conference where top managers of the First Bureau reported experience, initiating nationwide use of scientific management |
| 1958 | The construction experience of building Fulaerji published in “The Construction Experience of the Fulaerji Heavy Machinery Plant” |
| 1966-76 | Tanzania and Zambia railway construction, the largest Chinese aid project in the world |
|  | 1982 | Creation of CSCEC via the merger of eight Bureaus. Strategy of building “high, large, excellent and cutting edge” projects |
| Booming Domestic Market (1980s – 2010s) | Int’l contract projects (1980s-2010s) | 1982 | Requested by the central government to go overseas to ‘look for jobs’, first construction company to do so  Kuwait office |
| 1983 | Contract to construct the Ghazi Pull irrigation project in Iraq.  US office |
| 1985-  2000s | Palm tree island, 7 star hotel and the Formula One sports stadium. Learnt how to ‘rent out’ surplus workers to reduce the cost, to allocate materials and labor force on-site more scientifically. |
| 1983 | Contract for International Trade Centre, the highest building in China at the time. Adopted the sliding mode method. Created “Shenzhen Speed” |
| 1987-1997 | Learnt and applied “Lubuge experience”, the first project in China to use international contract management systems.  Established a dedicated organization responsible for learning and required each subsidiary to record how they learned and applied to their project operation. |
| 1991 | Use of CSCEC sign in all operations to enhance the brand and corporate integration |
| 1992 | China Overseas Land & Investment Limited (one of the CSCEC’s overseas subsidiaries) listed on The Stock Exchange of Hong Kong. |
| 1999 | Incorporation of 6 firms formerly owned by and separated from the Ministry of Construction. |
| 2001 | Proposed that the strategic objectives of the CSCEC focused on business performance, group achievement and scientific management. |
| 2005 | Transformation towards infrastructure construction. "three bigs" strategy: big market, big owner, and big projects, to strengthen income, profit and brand |
| 2006 | Debut in Fortune Global 500, ranking 486 |
| 2007 | Ranks 396 in Fortune Global 500.  China State Construction Engineering Corporation Ltd formally established and listed. |
| 2008 | Ranks 385th of Fortune 500; Among "China's most admired companies" ranked by Fortune. |
| Int’l investment projects (2009-2010s) | 2009 | Listed on Shanghai Stock Exchange  US subsidiary signed a US$1.9 bn Baha Bahamas resort project. Transform from “a traditional construction contract firm to an integrated investing firm” as project involved knowledge of investment, financing, law, planning, designing, construction, real estate and government public relationship. |
| 2010 | Ranks 187 in Fortune Global 500 with revenues of US$38.1bn.  Business structure transformed from house construction domination to the three core businesses of house construction, infrastructure and real estate. |
| 2011 | Ranks 147 in Fortune Global 500 with revenues of US$54.7bn  Set up the core value as “quality assurance, value creation".  Strategic Cooperation Agreement with Tsinghua University for R&D and talent management.  Create R&D labs on structure, geotechnical & underground engineering and green building, and information systems. |
| 2012 | Ranks 100 in Fortune Global 500 with revenues of US$76.0bn  Building Africa Union Conference Centre (AUCC) in Ethiopia.  Wins bid for Shenzhen subway project, largest single project at Yuan15.3bn  Obtained the most qualification certificates for general contracting of construction projects  Strategic cooperation agreement with Fujian government, Hubei government, Huaneng Group, Shangqiu city government  Built new CCTV head office, praised as a "construction miracle." Innovative methods developed, winning 10 patents from the Chinese government. |
| 2013 | Ranks 80 in Fortune Global 500 with revenues of US$90.6bn  Wins bid for two 5-star hotels in Algeria (Marriott Hotel in Constantine and Sheraton Hotel in Annaba); First 7-Star Hotel, Centauris, opened in Pakistan  First flight at Mauritius New Airport built by CSCEC  Contract for LCT Complex Project in Pusan, South Korea  World Society of Tall City Building awarded CCTV New Office Building, constructed by CSCEC, “the World’s Best Tall Building Award”  Won bid for Nanning Subway Line 2 Project for Yuan 15.6 bn |

Source: Company documents, website, research, and interviews.

Table 4. Types of learning-by-doing and their processes and representative quotes by period

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Integration** | **Trial and error** | **Repetition** | **Extension** |
| **Action** | Integrate and coordinate external knowledge and expertise into the company | Undertake a new activity until success or until lack of financial or managerial support | Repeat known activity and reduce the errors and mistakes | Undertake a more complex activity that builds on existing activities |
| **Learning processes** | Create complementarities and synergies among integrated knowledge | Find solutions to problems | Avoid mistakes in activities | Stretch knowledge base |
| **Knowledge actions** | Coordinate | Select | Transfer | Expand |
| **Source of efficiency** | Not create new knowledge by using existing external knowledge | Not repeat analysis and decision making by using created solutions | Not repeat errors by reducing variation in actions | Not create new knowledge by using existing internal knowledge |
| **Capability developed** | Create amalgamated knowledge, coordination and management, corporate culture | Problem solving, entrepreneurship, and risk taking | Process efficiency | Scope and growth |
| **Human resource success factors** | Amount and variety | Imagination and intuition | Obedience and improvement | Skills |
| **Barriers to success** | Establishment of inadequate procedures from “wrong” external knowledge | Use of second-best solutions | Lack of experimentation; lack of desire to get out of the comfort zone | Undertaking too complex activity; inferior structure and synergy |
| **Emerging country influence** | Fewer specialized providers | Higher knowledge isolation | Higher market growth | Increased consumer sophistication |
| Learning from building a new country (1950s-1970s) | “The construction team learned to apply knowledge in practice, following Soviet recommendations. However, they also creatively made various components ​​in the pre-factory and shipped them to the construction site for installation to improve efficiency” (Zhang et al., 2004). | “After careful research and many experiments, the caisson was successfully completed by continuously adding and adjusting atmospheric pressure during the installation process” (Meng, 2011). | “In 1955, the First Bureau was assigned the new task of constructing the Fulaerji First Heavy Machinery Plant. It applied its best practices from FAW to the new project” (Meng, 2011). | “However, the First Heavy Machinery plant was a larger and more technologically demanding project. The most difficult part was to install the caisson. … The project was unprecedented not only in China but also in the Soviet Union. The technical team of the First Bureau had to independently search for feasible ways” (Meng, 2011). |
| Learning from international aid projects (1950s-2010s) | “The engineering and construction challenges of this section had seemed almost insurmountable” (Monson 2009, p. 47). “The Chinese had to seek domestic experts’ advice remotely or inviting them to the site” (Senior manager of Tazara, 2013). | “Trial and error as well as repetition were all involved in the process in order to find a solution and improve the speed and quality” (Senior manager of Tazara, 2013). | “A [Chinese] technician would assemble and dismantle a piece of machinery and encourage his African apprentices to follow until they got the procedure right” (Monson, 2009, p. 44). | “There were technical challenges caused by local geological conditions and lack of adequate tool and equipment” (senior manager of Tazara, 2013). “They [local employees] were given intensive training in some cases. The Chinese “preferred to teach without words” due to the language barrier (Monson, 2009, p. 44). |

Table 4. Types of learning-by-doing and their processes and representative quotes by period (continued)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Integration** | **Trial and error** | **Repetition** | **Extension** |
| Learning from the Booming Domestic Market (1980s – 2010s) | “The learning process was also considerably enhanced by working side by side with international construction firms [in China]…. Taisei’s tunnel drilling speed was two to three times higher than that of the Chinese. …The Japanese project management team used a hybrid managerial system …to ensure effective and efficient management” (Zhang, 1997). | “However, the sliding mode method had never been tried in China before. The first three trials of the sliding mode technique all failed. Under extreme pressure, the team carefully decomposed the previous failures, identified the causes and concluded that the filling speed was crucial to success. … After a night of effort, the trial commander declared the success of the [fourth] trial” (Mei, 2012) | “As the project team became increasingly familiar with the operation and techniques, the construction speed increased. They spent an average of seven days constructing one floor during the first 5-10 levels, then 5 days per floor in the 10-20 levels, 4 days in the 20-30 levels, and 3 days in the 30-50 levels. The fastest record was 2.5 days for one floor” (Mei, 2012). | The main challenge was how to build the overhang without the towers buckling under the strain, before they were joined, and without a supporting third tower or lifting a frame from the ground. There were no ready-made specifications for constructing such a challenging building in either CSCEC history or China’s construction history in general (Head of marketing of CSCEC, 2012). |
| Learning from international contract projects (1980s-2010s) | “As early as 1982 and 1983, our company invited Professor Lu Di, the famous law professor, to hold seminars on FIDIC regulations so that our staff received proper training on basic knowledge of international project management. We were the earliest construction firm in China going overseas for international contract projects after proper training” (Deputy CEO of CSCEC, 2011). | “To meet the deadline, the team promptly imported four sets of TC2000. … no one was able to use the equipment. … In the shortest time we translated two large volumes of user instructions. Against the instructions we tried and experimented, and were able to master the operation technique in two days. The advanced instrument greatly improved mapping speed. Then ... we had difficulties to mapping accurately [until we] invented various semaphores” (Wang, 2012). | “Contract application was so important. Hence, I made great efforts to read contracts. ..I not only read it every day, but also memorize every term. After being familiar with the contracts we used, I also learnt other kinds of British contracts. In less than three years, I was able to protect our interests by applying contract terms freely, and also learnt negotiation techniques” (Chen, 2012:x). | “As you know, Dubai was hit badly due to the financial crisis. … We are lucky that we have not failed as we abruptly adjusted our operation and improved our communication with the project owner. …But we learnt that we should not jump in the “looking good” market but need to carefully analyse risks and better prepare for the risks” (CEO of CSCEC Middle East, 2010). |
| Learning from international investment projects (2010s-) | The Baha project involved various industries requiring knowledge of investment, financing, law, planning, designing, construction, real estate and government public relationship. So we mobilized more than 1,000 experts to work on the project. They examined more than 1000 documents in English and Chinese” (Yuan, 2011). | “Construction firms need to [try new mode of business and] fully make use of the state policy and strengthen their cooperation with the Chinese government, banks, large SOEs, development funds and other institutions” (Deputy CEO of CSCEC, 2011). | While this newly invested Baha project was operating smoothly, “there will have more such projects taking place if good opportunity occurs” (Head of Marketing of CSCEC, 2012). | “But this project was suspended in 2008 due to the financial crisis. After careful analysis, we adjusted our role from a contractor to a general contractor, investor and financial consultant to rescue the project” (Yuan, 2011). |

Figure 1. Learning-by-doing and capability upgrading in emerging market firms

