Strategic issues in relation to the emergence, development, and protection of innovation capabilities in emerging economies

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Abstract

Innovation capabilities is an emerging topic in modern management literature, that consider its practice as one of the main sources of sustained competitive advantage in the firm.

This study attempts to analyze and compare current literature in three fields: technology and innovation management, technological capabilities accumulation, and organizational structures effects on innovation. The resource based view approach guides this paper.

The need to conjoint the integrative approach of a firm (in strategic management) with the dynamics of capabilities accumulation processes is identified as an important gap in literature. Stronger theoretical support in these fields is also found as required for further developments.
Strategic issues in relation to acquisition, leverage, and protection of innovation capabilities

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Introduction

Technology and Innovation Management (TIM) literature considers innovation as a critical factor that creates sustained competitive advantage in the firm (Schumpeter 1994, Utterback, 1996; Christensen, 1997, Afuah, 2003). Technological capabilities are pre-requisite for technological innovation in the firm (Kim 1997; Ferraz et. Al 1992; Savory, 2006).

This paper will discuss the strategic issues regarding the emergence, leverage and protection of innovation capabilities in organizations. It starts with basic definitions used throughout the report and then it explores the nature of Innovation Capabilities and current academic issues regarding its emergence and evolution, covering technology and innovation management, technological capabilities accumulation literature, and the organizational structures effects on the innovation process.
Background

Definitions and the emergence of innovations

Science: a department of systematized knowledge as an object of study

Technology: the practical application of knowledge especially in a particular area

Invention: a device, contrivance, or process originated after study and experiment

Innovation: the introduction (to the market) of something new

Innovation is also defined as the use of new knowledge to offer a new product or service that a customer wants, and it implies both inventive and commercialization activities (Afuah, 2003). The European-Commission (1995) defines innovation as “the successful production, assimilation and exploitation of novelty in the economic and social spheres”.

Stokes (1997) states that “the defining quality of basic research is that it seeks to widen the understanding of the phenomena of a scientific field” (:7), while “applied research is directed toward some individual or societal need or use” (:8). He summarized their different goals as “understanding” for basic research, and “use” to applied research. Thus basic research can be related to the science domain, while applied research regards technological innovation.

With both disciplines an organization can develop “inventions”, but that is not the final objective of a firm in a competitive market, but to find ways to generate above normal economic rents creating continuously sources of competitive advantage. Technology and Innovation Management (TIM) theory studies the issues regarding on how to move from inventions toward innovations, and in this field Technological Capabilities are the most important means in order to develop innovative activities that, properly implemented, can conduct to creating sustained competitive advantage and this is the unit of study of this paper.

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1 Merriam-Webster online: http://www.m-w.com/
2 For an extended explanation of both terms and the emergence of modern paradigms regarding science and technological innovation see Stokes (1997).
Technological and Innovation Capabilities


The RBV is concerned with differences among firms and the way they reach and sustain competitive advantage, and defines the firm as a bundle of resources and capabilities and states that the root of the competitive differences is based on the heterogeneous resources owned by them (Penrose, 1995). In order to generate a sustained competitive advantage a firm shall own valuable, rare, inimitable and insubstitutable resources, competences and capabilities. (Barney, 1991). I use in this paper Helfat’s definitions or resources and capabilities: “Organizational resource refers to an asset or input to the production … that the organization owns, controls, or has access to on a semi-permanent basis. … organizational capability refers to an organizational ability to perform a coordinated task, utilizing organizational resources, for the purpose of achieving a particular end result.” (Helfat, 2003a).

Innovation Capability Attributes

Innovation capability is defined by Kim (1997) as the ability to create new and useful knowledge based on previous knowledge; and by Burgelman (1983), as “the comprehensive set of organizational characteristics that facilitate and support innovation strategies”. Capabilities are organizational abilities, composed by routines, and in continuous change. These definitions can be extended adding these attributes, considering that innovation capabilities are a higher order “integration capability”, it means that they have the ability to mould and manage different key organizational capabilities and resources that successfully stimulate the innovation activities (Lawson and Samson, 2001). In the same sense Henderson (1994) highlights that this kind of capabilities has the ability to integrate knowledge across boundaries inside a firm, creating sources of competitive advantage.

Thus an innovation capability will be supported by many other organizational capabilities, all the necessary ones to enable innovation activities, creating “new” things,
for internal use (as new methods of work) and for offering to the market (as products, processes, and services).

**Technological Capabilities Accumulation Literature**

Research developed regarding innovation in firms in emerging economies have identified that one of the most critical factors in order to create the innovation capability is the accumulation of technological capabilities (Bell & Pavitt, 1992; Kim, 1997, Dutrénit, 2004; Figueiredo, 2001).

Analyzing technological Korean firms, Kim (1997) developed a three-stage innovation model (duplicative imitation, creative imitation and innovation), that inverses the traditional innovation models. He developed qualitative research in order to design his framework, and he developed later empirical validation studies, where he could confirm the benefits of current innovation models just after their customization to local context (Kim & Kim, 1985).

In a similar but different tradition, Bell and Pavitt (1995), based on Lall (1992), developed a technological capabilities taxonomy, where they identified primary (Investment and production) and supporting activities that are involved in the technological capabilities development. This taxonomy has been extensively used in empirical studies to picture the level of Technological Capabilities achieved by firms in emerging economies (as Figueiredo, 2001; Dutrénit, 2000 and 2004). It has also received criticism because of its static characteristic (it is useful for identifying actual innovation position), but does not provide information about how the organization got to that level of innovation maturity, in other words, it does not consider the dynamism that is inherent to changes in capabilities over time.

Under this tradition, Dutrénit (2000, 2004) studied a Mexican glass corporation in its process of building up technological capabilities. She reviewed relevant literature developed regarding firms in developed countries (she calls them as Strategic Management Literature) and literature around the building up of technological capabilities in industrial latecomer firms. She found a gap in the current literature in this transition stage (firms that have already built minimum base of knowledge but are still in the process of building up their first core/strategic capabilities).
Figueiredo (2001) studied “how and why latecomer companies differ in the way and rate at which they accumulate technological capability over time”, and analyzed the learning process as influence on the path of technological capabilities accumulation. He uses two longitudinal case studies regarding large Brazilian steel companies, and follows their path ascending in their innovation capabilities. He uses adaptations of Lall (1992) and Pavitt (1998) innovation typologies (from routines –basic, renewed, extra basic and pre.intermediate- to innovative –extra basic, pre-intermediate, intermediate, high-intermediate and advanced- levels of technological capabilities).

An identified gap in this literature is the analysis of the relationship between different organizational functions. Bell and Pavitt framework only considers a limited group of organizational capabilities (those highly related to technological innovation), ignoring other types of organizational capabilities, that have significant effects on the evolution of innovativeness levels of the firm. Organizational and managerial innovations were not considered when developing their framework, neither the collaboration among other departments and workgroups (e.g. human resources, IT, distribution and logistics areas, among others) when accumulating technological capabilities.

**Back to Strategic Management: Absorptive Capacity and Dynamic Capabilities**

Using a different approach and literature, Cohen and Levinthal (1990) defined Absorptive Capacity (ACAP) as the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends, and it is related to the firm’s level of prior related knowledge.

Technological capabilities and ACAP are related, and some authors consider them as referring the same phenomenon (Savory, 2006; Leonard, 1998), as I do in this paper. Thus, as Zhara and George (2002) and Cohen and Levinthal (1990) explain, Technological Capabilities (and ACAP) are dynamic capabilities and they have strong path dependent effects. Dynamic Capability is defined as the ability to integrate, build, and reconfigure internal and external competences to address environmental changes.

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3 See DeSarbo et. al (2005) for an extensive firm capabilities taxonomy, covering technological, managerial, marketing, IT, and other capabilities.
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(Teec et. al., 1990) and path-dependency implies that prior knowledge constrains and determines future advances in knowledge improvement.

**Capabilities Protection: Resources Inimitability and Causal Ambiguity**

Inimitability is one of the critical characteristics that, according to Barney (1991), a resource or capability should have in order to be source of sustained competitive advantage. Peng (2006) explains that firms can imitate by direct duplication and substitution. He also considers, three underlying factors that make a capability difficult to duplicate: **time compression diseconomies** (it is not possible to acquire in a short time the resources and capabilities that the focal firm developed along time), **path dependencies** (earlier events determine their later events) and **causal ambiguity**. He defines causal ambiguity to the difficulty of identifying the causal determinants of successful firm performance.

Time compression diseconomies and path dependencies can be solved by innovative followers or imitators, and the organization that owns valuable technological capabilities can not strength these imitation barriers, but it can intervene in the case of causal ambiguity.

Causal ambiguity was initially identified by Lippmand and Rumelt (1982). In their article they stated that in the presence of differences among firms, the conventional view (free will and competition) would eliminate the differences, but as it does not happen, there should be some market power or impeded barrier. But in the presence of uncertainty because of ambiguity regarding causal connections between routines and outcomes, the elements that cause performance different can not be identified. Thus complete homogeneity can not be attained. The patenting strategy is identified as a source of this phenomenon, but it can not be applied in competences or capabilities, and also over 60% of patents are legally imitated within 4 years of patent-granting.

Reed and DeFillippi (1995) argued that the causal ambiguity can be caused when the skills and resources of an organization have three characteristics: tacitness, complexity, and specificity, creating this way strong imitability barrier. They remarked the importance of maintaining tacit knowledge inside the firm. Therefore it is necessary to
maintain high levels of tacit knowledge. It calls for the human resource factor that has not been sufficient studied in the innovation management literature.

Haier Group\textsuperscript{4}, an emerging and global white appliances leader based on China, has attempted to spread out their world-class internal processes among other Chinese corporations. “Haier’s core competencies lie in the company’s collective ability to coordinate a number of diverse production skills, brand name maneuvering and customer services” (Yi and Ye, 2003:234), all of them with high contents of tacit knowledge and causal ambiguity. Even though Haier has provided during this technology transfer process necessary manuals and procedures to other Chinese companies, they could not replicate such success in performance and profitability. As a confirmation of causal ambiguity as a strong source of isolation mechanisms Haier does develop successful technology transfer throughout the corporation around the world without any significant problem.

**Emergence and Evolution of Technological Capabilities**

TIM literature in Strategic Management\textsuperscript{5} considers Technological Capabilities as pre-existent, and they analyze their evolution, as a dynamic interaction of them with a changing environment. As a result of this evolutionary process, heterogeneity of firms in the technology and innovation fields emerges.

Helfat (2003b) consolidates an interesting group of papers (mostly published in special editions in Strategic Management Journal) regarding the emergence, development, and change of Organizational Capabilities and TC are included among them.

She summarized her main findings as:

a. Entrant success depends on pre-existing resources.

b. Capabilities change over time, firms respond to changes

\textsuperscript{4} Hair Group is one of the most successful Chinese Corporation. It has become the fourth home appliances manufacturer in the world, with world-class quality and R&D processes.

\textsuperscript{5} This study considers Technological Capabilities Accumulation literature and Catching-up literature apart of Technology and Innovation Management literature. Former branches of literature do consider that firms in emerging economies lack of necessary base of knowledge to compete at the technology frontier (Dutrenit, 2000) and study the process of capability accumulation.
c. The initial conditions and path-dependency results in firm heterogeneity in an industry

d. There exists a co-evolution of capabilities with organizational form, products and market structure

Another gap in literature is to conjoint Strategic Management studies regarding capabilities development with Technological Capabilities Accumulation literature; the former providing an integral approach of all organizational capabilities (technological and non technological ones), and the latter with accumulation processes that create innovation abilities to latecomer firms in emerging economies. This combination of theories can provide a more complete analysis of internal process of generating initial innovation capabilities in organizations.

Organizational structures and Innovation: into Innovation Models

The transformation of invention into innovation, or the evolution of scientific knowledge to technology and later to products and services (the practice of innovation capabilities), has been the unit of study of TIM literature in the last 30 years, and it has effects on innovation capabilities development.

Rothwell (1994) analyzed the dominant perceptions of the innovation process since 1950s until late 90s, and he developed five generations innovation models. These models started from the classical or linear model that defined the modern paradigm regarding science and innovation.

After World War II (50s-60s) there were unparalleled rates of economic growth and large industrial expansion based on new industries and technologies, it was an excellent environment for “technology push” strategy. After rapid expansion of the first generation firms changed their strategies towards rationalization of technological change, and they competed intensively for gaining market share, emphasizing the marketing issue (“market-pull”). The third generation model came with oil crises, forcing to optimize resources employed in the innovation process. Innovation studies started in during this period, showing that neither technology nor market should direct the
innovation projects but their interaction (the “coupling” model). The fourth generation innovation model emerged with the appearance of new elements, as IT support, global competition and global strategic alliances, in parallel with the emergence of Japanese competition that pushed to integrative and parallel innovation activities. The fifth generation is still emerging in the form of an open learning organization that takes advantage of internal and external knowledge in its innovation projects conducting to technological capabilities accumulation (Hobday, 2005) (See Figures 01 and 02).

The further independence of commercialization cycles from basic and applied research was consolidated in the second generation innovation models, where market forces shaped the innovation process, even sacrificing scientific advances. Basic research developed by firms was limited to some industries. This research started to be developed mainly by government-funded and university-related research centers.

![Figure 01: Innovation models: First and second generations](image-url)
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Third Generation: The “Coupling” Model of Innovation

Fourth Generation: The “Integrated” Innovation Model

Fifth Generation: Innovation as a Process of Know-How Accumulation

Nelson (1959) explained the economics reason why many corporations abandoned their efforts to maintain basic research in their operations. He defined basic research as the activity directed toward the advancement of knowledge, creating always social gains, while organizations expect private-profits from their investment on
research, then they limit them to applied research and product development activities. Only large corporations with broad technological base can afford these efforts, as whatever direction can take the scientific discovery it can be valuable for the corporation. This is the case of General Electric, IBM, and the large Japanese corporations as Toyota and Sony, and lately the Korean “chaebols” as Samsung or LG.

Another emergent innovation strategy is based on the use of strategic research alliances, between firms that are even competitors in the same industry, or with universities and research centers using different types of research agreements, creating what it is called technology transfer. Innovation appropriability is a branch of TIM literature that study how the innovation ownership shall be or can be assign in such agreements.

Nowadays most of basic research is developed by university and government-funded research centers. Technology policy promotes this approach, suggesting that industry should worry just about applied research (Gibbons and Jonhnson, 1974).

Gibbons and Jonhston (1974), and later Faulkner (1994) developed empirical studies, finding that just 8% of innovations in their samples were triggered by scientific knowledge; most of innovations are based on internal sources. This confirms the idea that “science tends to build on old science and technology on old technology” (Faulkner, 1994). Another obstacle for this integration (science and innovation) is the time lag between a scientific discovery and the introduction of products derived from them (it varies from 10 to 40 years). There are some industries that are exception to this behavior, as biotechnology and semi-conductors, where many firms are spin-outs from research centers, and the activities and required resources for basic research and development projects are quite similar. In these industries a scientific discovery triggers immediately potential applications in market.

Even basic research and R&D require human resources with similar scientific/technological background, the former require what society calls “scientists”, and the latter require “engineers”, and both profiles are quite different. Scientists are

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6 See Etzkowitz and Leydesdorff (1995)
“theory-based” and engineers more “empirical” (Faulkner, 1994), however this distinction can be sometimes blurred.

R&D has a more practical-artifactual orientation, surrounded by political and economical factors, with more heterogeneous activities than BR, as well as strong local and tacit knowledge (Faulkner, 1994), and all of these requirements call for different technological capabilities. R&D requires effective organizational capabilities that can couple technological and market knowledge, trying to identify technological as well as market opportunities, while basic research lacks of these capabilities (Faulkner, 1994).

Firms can not ignore basic research discoveries; however they should identify which ones of these discoveries are useful for their performance. This is one of the characteristics of Absorptive Capacity (Cohen and Levinthal, 1990). They found that firms require to develop “technological sensing” abilities in order to identify promptly the potential market value and commercial applications of scientific knowledge. Firms leverage this ability by developing Applied Research activities and investing in R&D continuously.

**The New Product Development (NPD) Function**

This paper analyzed the relationship between basic research, applied research and R&D or product development function. This section discusses the New Product Development (NPD) function, which has the responsibility to transform technological ideas, with market-oriented recommendations, into products that can be sold in the market.

NPD has as main function to continuously develop and introduce new products to the market, applying this function technology and innovation become sources of sustained competitive advantage.

Previous empirical studies found that NPD confronts high failure rates (e.g. Crawford, 1987). Thus, even it opens new opportunities to the firm, the substantial risk associated to this function should be considered, and it is one of the most discussed issues in TIM literature (Brown and Eisenhardt, 1995). An organization shall adequate

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7 Local knowledge is specific to a firm, as knowledge from suppliers, materials used in its processes, and user needs.
this function to its organizational structure, or it should develop special structures in order to optimize this process. Ernst (2002) develops an extensive literature review regarding NPD, and he found that studies around NPD still lack sufficient theoretical support (e.g. formal causality that explains successful innovations).

Birchall and Tovstiga (2005:191-192) describe a typical NPD process:

a. Stage 1: Idea generation: initial screen, preliminary assessment
b. Stage 2: definition: decision on business case
c. Stage 3: development: post-development review
d. Stage 4: Validation: pre-commercialization decision
e. Stage 5: Commercialization
f. Post-implementation review

Traditionally there existed the R&D department, which from time to time interacted with other departments (specially marketing and production), this was the case of the first and second generation of innovation models (Rothwell, 1994). This structure has evolved to project-oriented activities and cross-functional teams (see Ernst (2002) for empirical studies regarding organizational aspects of NPD). The need to interact with other departments and with environment (including competitors) was essential for reducing the uncertainty of this kind of projects, as well to shift from “technology-push” to “market-pull” strategies. Strong management commitment, the project leader role and dedicated project teams are other organizational conditions. The matrix organizational structure has been the most applied structure in successful NPD projects.

Faulkner (1994) stated that Organizational and Communication Capabilities have become critical factors for granting Innovation success. Empirical studies (Song et. al., 2005; Sherman et. al., 2005) also demonstrated the benefits of complementarities between R&D or Technological Capabilities with Marketing, finding interaction effects among those departments, with larger importance in high-turbulence environments.

*Innovation and Corporations*
A corporation is a unified group of business units, grouped within divisions and a corporate centre or head office. The focus of the strategy moves from the “how the organization will compete in an industry” (business-unit level concern) toward “what businesses should the organization be in”. It is a portfolio of business units that can be more or less diversified, depending of the corporate strategy.

According to Transaction Cost Theory\(^8\), a corporation provides additional advantages to the firm (see Rugman and Verbeke, 1992), and these can be applied in the Technological Capabilities:

a. A Corporation can mix the firm-specific and transactional advantages, exploiting its capabilities of economizing on transaction costs as the corporation can create capabilities to develop optimal internal coordination and control mechanisms.

b. Multinational corporations can take advantage of country-specific (or locational) advantages (structural market imperfections or the possibility to economize on transaction costs by reducing risks)

c. Internationalization advantages, including the mix of internationalization strategies possibilities (exports, licensing, joint ventures, FDI, etc.)

Other advantages for leveraging Innovation Capabilities come with the economies of scale and scope that a Corporation provides to the different business units. Thanks to the economies of scope (cost savings across functions or units) the Corporation can fund complementary Innovation Capabilities that in other case would not be implemented.

Multinational Corporations use to adopt centralized or decentralized R&D structures, with mixing results. Argyres and Silverman (2004) found that centralized operations reduce transaction costs associated with R&D coordination across units, and generate innovations with larger and broader impact on technological evolution. These results are interesting because it goes against the trend in MNC to decentralize their R&D

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\(^8\) Transaction Cost Economics studies the interface between firm and environment considering contractual or exchange events (Williamson, 1975). Hierarchical governance modes will emerge when transaction costs of markets are high, even they have their own bureaucratic costs. Then there is a permanent trade-off between the transaction costs associated with the market mode, a firm’s necessity of control and the costs of governance hierarchy.
operations (Technological Capabilities deployment) in order to gain country-specific advantages (e.g. more specific local market knowledge). Holm and Pedersen (2000) develops this decentralization corporate strategy, analyzing the advantages of creating “Centres of Excellence”, finding the emergence of subsidiaries as strategic units generating innovation activities, and creating positive impacts on the long-term development of the corporation.

**Conclusions and Further research**

This paper became a literature review of Technological Capabilities management, covering TIM, Technological Capabilities Accumulation, and Strategic Management literature related to the innovation phenomenon, identifying the main strategic issues regarding the emergence, leverage and protection of innovation capabilities.

It is clear the central importance of Innovation Capabilities for obtaining sustained competitive advantage in the firm, as they are the conditions to deliver innovations to the market, but at the same time this study found that even though there are lots of high quality researches regarding these topics, this field still lacks a strong theoretical support. Most of the studies have been empirical oriented, and the most interesting theoretical papers studies just cover some industries or a group of companies, and they do not allow a general theory of Innovation Capabilities development.

The prevalence of qualitative research over quantitative research in this field is another symptom of its youth inside the TIM and Strategic Management literature. As this field gets stronger theoretical developments it will be consolidating as a good academic branch and it will develop causal models that can better explain the emergence of the innovation process in organizations.

The link between Innovation Capabilities management and other fields, such as Corporate Strategy management, is still a new field to explore, and it becomes more important as globalization and industry consolidation is emerging in the new competitive environment.
Finally, the study finds another gap in the literature regarding Technological Capabilities in emerging economies. These studies have focused in technological innovations, and have limited the scope of analysis to technology-related areas and capabilities, neglecting the effects of other areas and capabilities of an organization, such as managerial and organizational capabilities, and support areas, that in an integral and synergetic effort contribute in the development of innovation capabilities.

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