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Technological Innovation Strategy: A Case Study in Brazilian Subsidiaries of MNCs

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Technological Innovation Strategy: A Case Study in Brazilian Subsidiaries of MNCs

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TYPE: Case

Estrategia de innovación tecnológica: un estudio de caso en filiales brasileñas de empresas multinacionales
Estratégia de inovação tecnológica: um estudo de caso em subsidiárias brasileiras de companhias multinacionais

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This article analyzes the process of technology strategy formulation in two cases of Brazilian subsidiaries from telecom industry. One company belongs to the equipment layer (EQUIPCOMPANY), and the other to the network layer (NETCOMPANY). In EQUIPCOMPANY, technology strategy and corporate strategy are formulated in conjunction, and the subsidiary is involved in the creation of global products. The main advantage of this approach is the alignment around a common vision and the synergy created among subsidiaries. However, the subsidiaries' autonomy to create innovations highly adapted to a specific country is limited. In NETCOMPANY, the technology strategy derives from the marketing vision of the future, and the Brazilian subsidiary can define its own strategy, merely requesting parent company approval for implementation. This approach brings agility to decision making and allows its subsidiaries to create innovations highly adapted to local specific needs. Nevertheless, NETCOMPANY faces poor coordination among subsidiaries, possible duplication of work and investment, and a lack of synergy and collaboration on innovation projects.

Este artículo analiza el proceso de formulación de la estrategia tecnológica en el caso de dos filiales brasileñas de empresas del sector de las telecomunicaciones. Una de ellas actúa en el campo de los equipamientos (EQUIPCOMPANY) y la otra en el campo de las redes (NETCOMPANY). En EQUIPCOMPANY, la estrategia tecnológica y la estrategia corporativa se formulan conjuntamente, y la filial participa en la creación de productos globales. Las ventajas principales de este enfoque son el alineamiento en torno a una visión común y la sinergia creada entre filiales. Sin embargo, el grado de autonomía de las filiales para crear innovaciones altamente adaptadas a cada país es limitado. En NETCOMPANY, la estrategia tecnológica se deriva de la visión de marketing del futuro, y la filial brasileña puede definir su propia estrategia, limitándose meramente a solicitar la aprobación y la puesta en práctica de la empresa matriz. Este enfoque ofrece una mayor agilidad en la toma de decisiones y permite a sus filiales crear innovaciones altamente adaptadas a las necesidades específicas de cada país. No obstante, la coordinación entre las distintas filiales de NETCOMPANY es baja, lo que se traduce en una posible duplicación del trabajo y de las inversiones y en una falta de sinergias y de colaboración en proyectos de innovación.

Este artigo analisa o processo de a formulação da estratégia tecnológica em dois casos de subsidiárias brasileiras do setor de telecomunicações. Uma empresa pertence à camada de equipamentos (EQUIPCOMPANY), e a outro à camada de rede (NETCOMPANY). Na EQUIPCOMPANY, a estratégia tecnológica e a estratégia corporativa são formuladas conjuntamente, e a subsidiária participa da criação de produtos globais. A principal vantagem desta abordagem é o alinhamento em torno de uma visão comum e a sinergia criada entre as subsidiárias. Contudo, a autonomia da subsidiária para criar inovações altamente adaptadas para um país é limitada. Na NETCOMPANY, a estratégia tecnológica é decorrente da visão de marketing do futuro, e a subsidiária brasileira pode definir sua própria estratégia, precisando apenas requisitar a aprovação da matriz para implementação. Esta abordagem traz agilidade para tomada de decisão e permite que suas subsidiárias criem inovações altamente adaptadas para necessidades locais específicas. Entretanto, a NETCOMPANY sofre com a deficiência na coordenação entre subsidiárias, possível duplicação de trabalho e investimento, e falta de sinergia e colaboração em projetos de inovação.

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1. Introduction

Innovation is a theme which is highly debated today, both in academia and in the business context. However, even with large investments in innovation, many companies are frequently surprised by often smaller competitors that take advantage of existing opportunities, launching new products that meet client needs. Just to cite one example, Microsoft, whose annual R&D budget exceeds US$ 9 billion, is constantly threatened by competitors or new technologies. This occurred with browsers when Netscape came out, with an Internet ad and search market which is now dominated by Google, and more recently with the growth of social network sites like Twitter and Facebook.

Another issue is the increasing importance of developing country markets, especially those known as BRIC – Brazil, Russia, India and China. Multinational companies are realizing that such markets offer big opportunities, but also have specific needs. Many studies are confirming a tendency towards a more decentralized R&D structure, in which a more important role is being assigned to subsidiaries in the innovation process (Gassmann and Zedtwitz, 1998; Pearce, 1999; Blanc and Sierra, 1999; Chiesa, 1996).

Thus, it´s not enough to invest in or possess innovation resources. In the current globalized market, companies competing in high technology industries should develop dynamic capabilities to coordinate expertise and match a complex and rapidly changing environment (Teece, Pisano and Shuen, 1997; Eisenhardt and Martin, 2000). In this context, the process of formulating the technology strategy is a very important capability for a company to have a competitive advantage. This process aims to map company expertise, to identify future opportunities and threats, and to support decision-making about the desired future (Bone and Saxon, 2000). It is hoped that this process will aid the company in formulating a vision of the future and identifying possible scenarios which may emerge, allowing the company to take advantage of opportunities and mitigate threats.

The objective of the present paper is to analyze technology strategy formulation in Brazilian subsidiaries of multinational companies in a dynamic and innovative industry. We chose the telecom industry due to its innovative and competitive nature. The research question we address in this paper is: How do Brazilian subsidiaries of multinational companies in the telecom industry formulate their technological innovation strategy? Based on the literature review, two main aspects were investigated: whether technology strategy is derived from corporate strategy or whether both are formulated in conjunction, and a subsidiary´s involvement is in the process of formulating the technology strategy.

Key words
Technology strategy, innovation strategy, role of subsidiaries, telecommunication industry, dynamic capabilities

Palabras clave
Estrategia tecnológica, estrategia de innovación, papel de las filiales, sector de las telecomunicaciones, capacidades dinámicas

Palavras-chave
Estratégia tecnológica, estratégia de inovação, papel de susidiárias, indústria de telecomunicações, capacidades dinámicas

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2. Importance of technological innovation for competitiveness in the telecom industry

Telecommunications is a very dynamic and complex industry, involving many participants. In the table below, we present a layer framework proposed by Fransman (2002) for a better understanding of the different roles played by sector members.

Table 1: A Layer Framework of the Telecom Industry

Layer	Activity	Example Companies
VI	Customers / Consuming	-
V	Applications Layer, including contents packaging (e.g. web design, on-line information services, broadcasting services, e-commerce, etc.)	Bloomberg, Reuters, MSN, News Corp, etc.
IV	Navigation & Middleware Layer (e.g. browsers, portals, search engines, security, etc.)	Yahoo, Google, etc.
III	Connectivity Layer (e.g. Internet access, web hosting)	IAPs and ISPs (e.g. AOL)
TCP/IP INTERFACE		
II	Network Layer (e.g. optical fiber network, mobile network, DSL local network, Ethernet, frame relay, etc.)	AT&T, BT, NTT, MCI WorldCom, etc.
I	Equipment & Software Layer (e.g. switches, routers, base stations, servers, billing software, etc.)	Alcatel Lucent, Cisco, Nokia Siemens, etc.

Adapted from: (Fransman, 2002).

Galina and Sbragia (2004) studied seven telecom equipment manufacturers (Layer I of Fransman´s framework). In their research, they concluded that the equipment manufacturers have a major role in innovations in the industry. It seems that in the telecom industry, innovations are "supplier dominated", using a classification pattern proposed by Pavitt (1984). Other possible innovation patterns identified in Pavitt´s research are "science-based firms", in which companies rapidly apply basic research discoveries made both by universities and internal R&D, and "production intensive firms", in which innovations are lead by production departments. Another characteristic of the telecom industry is that the fast evolution of technologies accelerates the obsolescence of equipments and systems. Thus, it´s necessary to invest constantly, and often a company may have to choose among competing technologies without a definition of which of them will become the standard for the industry.

A discussion is needed about the drivers of competitive advantage in complex and dynamic markets. According to Teece et al. (1997) both SCP (*structure-conduct-performance*) and RBV (*resource-based-view of the firm*) approaches are insufficient to explain the competitive advantage in such markets. For the SCP approaches, including Porter´s (1980) five forces framework, competitive advantage derives from industry structure and from mobility barriers between strategic groups (Hoskisson et al., 1999). In high technology markets it´s very difficult to create

barriers to entry, and also the industry structure itself is not sufficient to explain superior performance. The RBV (*resource-based-view of the firm*) approach focuses on the firm´s resources, or a bundle of them, as a primary source of competitive advantage. Such resources must be valuable, rare, inimitable and non-substitutable to ensure a sustainable competitive advantage (Barney, 1991; Wernerfelt, 1984). For the "classic" RBV approach (Acedo et al., 2006), a sustainable competitive advantage cannot be nullified by competitors, but only by "unanticipated changes in the economic structure of an industry" (Barney, 1991, p. 103). Thus, for the "classic" RBV, changes are exogenous to the industry, and there´s a stability of the competitive advantage for companies which have acquired or developed a bundle of resources and barriers to imitation. This does not seem to be the case for the telecom industry, where changes are endogenous to the industry and a company can not only imitate, but must create superior technology. In order to explain the competitive advantage in contexts of rapid change, Teece et al. (1997) introduces the concept of Dynamic Capabilities, defined as "the firm´s ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece et al., 1997, p. 516). Eisenhardt and Martin (2000) complement this definition and argue that the dynamic capability must not be seen as a capacity to alter capabilities, but as specific capabilities that change the resources of a company in a dynamic way.

Successful companies are not only those that adapt themselves to the environment in a passive way, but are also those that identify opportunities, develop required expertise and drive technological change in the industry (Prahalad & Hamel, 1990; Patel and Pavitt, 1997). It´s also necessary to recognize that having dynamic capabilities doesn´t mean that a company can change completely from one strategy to another. According to Teece et al. (1997), dynamic capabilities are explained by processes, asset positions and evolutionary paths that a company has adopted or inherited. Empirical research confirms that companies have limitations to developing a large variety of unrelated technologies (Patel and Pavitt, 1997), which can be explained, among other factors, by limitation in knowledge or expertise that are difficult to accumulate (Dierickx and Cool, 1989). So the strategic choices made by a company about the competencies it will develop create a path of dependency (Barney, 1991) that may represent a constraint to change. On the other hand, a good decision about technologies that a company should develop may create a base of competencies that can be valuable in different products and markets in the future (Prahalad & Hamel, 1990; Wernerfelt, 1984).

In this context, the process through which a company develops an understanding of changes in the environment to be able to anticipate opportunities and threats, as well as develop strategic planning to enable decisions about key technologies that will be developed by the company, can be understood as a dynamic capability which is important to high-tech companies for several reasons: (a) the ability of the company to make timely changes in resources to take advantage of new opportunities will depend on this process (Eisenhardt and Martin, 2000); (b) from this process, a company can conclude that it is necessary to change other processes to adapt to a constantly changing environment (Teece et al., 1997); (c) and finally, if conducted well, this process will allow a company to invest in a set of technologies that will be important in the future, lessening the path dependency restriction that would arise if the company were investing in technologies not valued by the market.

Cunha (2009) analyzed two Brazilian telecom companies from the network layer using the perspectives of dynamic capabilities and asset complementarities. He criticizes the low innova-

tion rate of the traditional telecom service providers, stating that new entrants, such as virtual service providers like Skype and Microsoft's MSN have been faster in the service innovation process. In his analysis he attributes this to the companies' different focus on complementary resources. Traditional service providers usually outsource activities such as information technology and consumer service, which in his analysis are key areas for a company in order to adapt and offer innovative services to customers (Cunha, 2009).

Empirical research, then, suggests that companies from the equipment layer tend to be more innovative. However, innovations from this layer go through an initial adoption by a part of the network layer, which implies that different links in the chain must work very closely together. Furthermore, due to the dynamic characteristics of the telecom industry, it is expected that the technology strategy and the corporate strategy should be formulated in conjunction, and that telecom companies should constantly seek to develop dynamic capabilities to obtain competitive advantage.

We move on now to a discussion of technology formulation strategy.

3. Frameworks for Formulating Technology Strategy

The alignment of technology strategy (or that of R&D) and corporate strategy was and continues to be a challenge for many organizations. Even with large investments in innovation, it's common for companies to develop products and/or services that never reach the market or else fail, and on the other hand, they don't invest in the development of products and services that are important to remain competitive in the market. Thus, the identification of technological opportunities and threats is important for the company to be able to reevaluate its project and technological product portfolios (Vasconcellos et al., 2007).

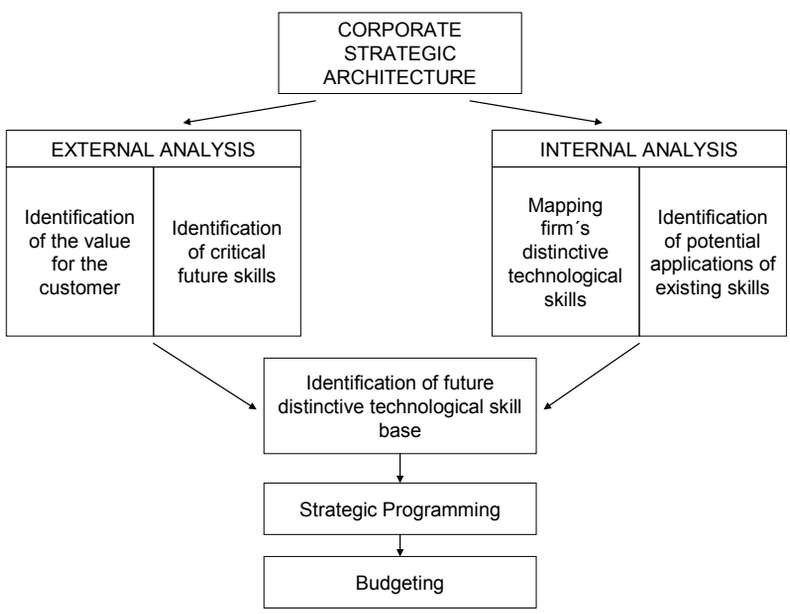
Roussel et. al. (1991) is known for the use of the expression "third generation R&D". This generation is characterized by its concern with the strategic alignment of R&D and the measurement of its results. There is also an increased participation of senior managers in the process of formulating the R&D strategy. Another concern is the balance of projects according to the type of innovation (radical or incremental), so that the company can realize its long-term vision.

Arasti and Packniat (2006) analyzed diverse technology strategy formulation frameworks. Such frameworks may adopt a rational or incremental process for formulating the technology strategy. In the rational process, companies are concerned with describing, understanding and analyzing the environment in order to determine a course of action and execute a plan. In the incremental process, the rapidly changing environment offers constraints to the rational process, and often companies make decisions and take actions in one direction, measure results and adjust goals, and finally define the next steps.

According to Chiesa (1998), existing models for formulating the technology strategy, which he

qualifies as traditional, are based on an analytical structure derived from the SCP strategic approach. So a company chooses its positioning strategy, and the technology strategy must give support to the corporate strategy. Frequently the analysis is centered in the product-market relation or in the technologies associated with the product. This approach assumes a relative stability in technologies over time. In competitive and dynamic markets, in which there is constant product renovation, the technology strategy is not only a consequence of the corporate strategy, but it also guides the development of competencies which can be used in other products or markets (Chiesa, 1998; Hamel and Prahalad, 1990).

Figure 1: Process For Formulating The Technology Strategy According to Chiesa



Source: (Chiesa, 1998).

Chiesa´s (1998) process starts from what he called "corporate strategic architecture", which means that the strategy itself is not yet defined, but rather there are broad definitions, such as the company´s mission and vision. The external analysis is focused on the identification of the value for the customer and the future critical skills. The internal analysis is focused on mapping the firm´s distinctive technological skills and on identifying potential applications of existing skills. This approach is concerned with issues raised by the dynamic capabilities and RBV approaches. Prahalad and Hamel (1990) emphasize that the company must build core competencies that are distinctive and that can be applied to different technologies and products in the future. This approach also recognizes the path dependency (Barney, 1991) created by the firm´s unique trajectory, which may be a constraint to change, but also constitutes an isolating mechanism against competitors because a firm may have an accumulated stock of valuable resources (competencies included) that requires a lot of time to develop (Dierickx and Cool, 1989).

As we have already discussed, innovations in the telecom industry are directed by equipment layer companies. However, both equipment and network layers are part of a rapidly changing environment. Often decisions are made with a high degree of uncertainty about technologies which will be effectively adopted on a large scale in the future.

4. The Role of the Subsidiary in the Innovation Process

The innovation process has become more and more globalized, with increasing participation of subsidiaries not only in adaptation, but also in creation of new products and services (Gassmann and Zedtwitz, 1998; Pearce, 1999; Blanc and Sierra, 1999; Chiesa, 1996).

According to Ghoshal and Bartlett (1988), subsidiaries may carry out three types of activities in the innovation process of MNC companies. One task is "creation", in which subsidiaries develop innovations locally for local use, generally with autonomy to define the local technology strategy. Another task is "adaptation", in which subsidiaries adapt innovations developed in a parent company or central R&D facility, generally following a global technology strategy. Finally, there is a "diffusion" task, in which a subsidiary transfers its locally developed innovations to the parent company or to other subsidiaries.

Nobel and Berkinshaw (1998) analyzed communication and control patterns in international R&D operations. They carried out a broad literature review and identified three different roles for subsidiaries in the R&D process:

- Local Adaptor: in this case, the local R&D´s role is to adapt innovations developed by the parent company.
- International Adaptor: local R&D not only adapts parent company´s innovations, but also develops some local innovations, giving support to local production.
- International Creator: in this case, local R&D participates in the process of global innovations creation. Local R&D is subordinated to the headquarters R&D unit, and sometimes it doesn´t have a connection with local production.

There is also some question as to whether the R&D internationalization generates results. Sing (2008) analyzed patents deposited in the US between 1986 and 1995 and concluded that R&D activities dispersion was associated with a negative effect on the quality of innovation. Several studies show that it is not enough to internationalize R&D activities. Mechanisms to integrate the dispersed knowledge among diverse units are necessary to improve the organization's capacity to innovate (Ghoshal and Bartlett, 1988; Sing, 2008).

Subramanian and Venkatraman (2001) studied transnational new product development and concluded that the transfer and deployment of worldwide subsidiaries' knowledge is associated with greater transnational new product development capabilities. A transnational product is a product developed simultaneously for many different markets, containing both common

global characteristics, as well as specific ones to match local market requirements. This is in contrast to a global product, which by definition is one with a single focus on the similarities between different markets. As there are different levels of autonomy and involvement of subsidiaries in the innovation process, one also assumes that there are differences in the involvement of the subsidiaries in the process of technology strategy formulation. This is one of the aspects that will be studied in this research.

5. Methodology

The nature of the present research is exploratory. We adopted the case study research method that is recommended when the goal is to investigate "how" and "why" questions about a little known, contemporary phenomena (Yin, 1989; Bonoma, 1985; Eisenhardt, 1989).

According to Yin (1989), research using the case study method does not allow hypothesis testing, but it is recommended to establish propositions that will serve as a guide for researchers´ investigation. In the next table we summarize the constructs and two propositions which were used as reference in this research.

Table 2: Constructs and Propositions Investigated In This Case Study

Theoretical constructs	Propositions investigated in this research
Dynamic capabilities explains competitive advantage of companies in high tech industries. The technological strategy is not a consequence of the corporate strategy, in the sense that they are interrelated and their limits are not clear. In high technology industries a company must reconfigure its resources dynamically to address a rapid and constantly changing environment. (Teece, Pisano and Shuen, 1995; Chiesa, 1998). According to Chiesa (1998), the technology strategy formulation process comprehends: external and internal analysis, identification of future distinctive technological skill base and strategic programming.	Proposition 1: the technology strategy and the corporate strategy are formulated in conjunction, stemming from the company's vision of the future
As we have not found a specific classification framework for the subsidiaries' involvement in the process of formulating the technology strategy, we use here the Nobel and Birkinshaw (1998) classification for the involvement of subsidiaries in the technological innovation process: local adaptor, international adaptor and international creator.	Proposition 2: multinational companies in high tech industries have a global technology strategy which is formulated with the involvement of subsidiaries. R&D units in subsidiaries have the role of international creator.

The sample in this study is theoretical (Eisenhardt, 1989), because our interest was to verify the technological innovation strategy formulation in companies in high technology industries. We have chosen the telecommunications industry due to its dynamic and innovative nature (Galina & Sbragia, 2004; Cunha 2009).

We also used the layers framework proposed by Fransman (2002) to choose two companies, each one belonging to a different layer. One of the companies is from the equipment layer, and will be referred as EQUIPCOMPANY. The other company is from the network layer, and will be referred as NETCOMPANY. The companies' identities were preserved to diminish interviewers´ resistance to or concern about giving information. In both companies we sought to identify and interview key individuals in the innovation process in the Brazilian subsidiaries. In EQUIPCOMPANY we interviewed the Head of Technology for Latin America, and in NETCOMPANY we interviewed the Technology Forecast Manager and the New Business Development Manager.

A semi-structured interview questionnaire was elaborated based on the propositions. All interviews were done with the participation of three researchers, following a recommendation from Eisenhardt (1989) to avoid personal interpretation bias. We also analyzed the companies' web sites, as well as some institutional presentations about the innovation process in both companies.

As a main limitation, the case study method does not allow statistical generalizations. Another limitation is the fact that we could not interview more individuals in the companies since other key persons involved in R&D were not available for interviews. However, these limitations do not diminish the importance of this research. Case study research allows theory building and constructs refinements and discussion for formulating questions that can be investigated further by quantitative research (Eisenhardt, 1989; Yin, 1989). Hoskisson et al. (1999) argue that RBV studies consider the firm as the unit of analyses. It is common for research of this type to use the case study method to analyze resources that bring competitive advantage.

6. Case Studies Presentation

6.1. EQUIPCOMPANY

• Company presentation

EQUIPCOMPANY is a global company with revenues of over US$ 15 billion. About 15% of this value is invested in R&D. It belongs to layer I of the Fransman (2002) model, developing equipment and network services for telecom service providers. It has about 60,000 employees, 16,000 of which are involved in research and development, including individuals from the customization team, responsible for adapting its solutions to specific customer needs.

EQUIPCOMPANY has a matrix organizational structure. There are three business units, each responsible for a set of products and services. Moreover, the company is structured in seven global regions, each with a corresponding regional director. Therefore, it is very common that an employee reports to a regional head and also to a head of the business unit.

• Technology Strategy Formulation in EQUIPCOMPANY

Each of the seven global regions has a Head of Technology who reports to the regional director. The Head of Technology for Latin America is based in Brazil and manages a team with eight people located in different countries in the region.

Twice a year, EQUIPCOMPANY holds a workshop attended by about 300 people representing subsidiaries all around the world. The goal is to analyze tendencies and the company´s positioning, and to establish a future vision for the next five years. In the workshop, employees are organized in thematic groups, with specific tasks that are presented to other participants during the event. Both technology strategy and the corporate strategy are formulated jointly in this process.

The head of Technology in EQUIPCOMPANY is responsible for visiting Chief Technology Officers (CTOs) in client companies in order to disseminate their future vision, checking to what extent it is aligned with clients´ evolution plans. These contacts with clients are also useful to identify future needs. There is a monthly meeting with the Heads of Technology to discuss technology strategy, taking into consideration the field information gathered from clients.

Besides the group formed by the Heads of Technology and their respective teams, there is a research group involving about 160 people globally. Specifically in Latin America, 15 people belong to this group. This research group is responsible for technology intelligence, looking for opportunities and threats, as well as forecasting and planning future technology. Thus, they are responsible for the technology roadmap of the products developed by the company.

They also adopt an innovation funnel model with five main phases encompassing idea generation, innovation proposal, acceleration of better ideas, and innovation project execution and launching. However, when a good idea or an unanticipated client need comes up, subsidiaries can request a faster process. In this case, the idea is presented to the regional director, who can submit the idea to the company´s board for approval, accelerating the whole process and avoiding the long route of a normal case.

Through an Internet portal, any employee from all around the world can search, monitor and contribute with innovation projects in progress or in maturation in any part of the world.

6.2. NETCOMPANY

• Company presentation

NETCOMPANY is a Brazilian subsidiary of a global company with business in the United States and seven other Latin American countries. It has over US$ 5 billion in revenues, and invests about 1% of this value in R&D. According to the Fransman (2002) model, it is situated in the network layer, offering connectivity to its clients through voice and data services. The company has about 8000 employees in Brazil. The Brazilian headquarter is located in the state of Rio de Janeiro, but main clients are located in the state of São Paulo.

R&D activities are distributed among three areas: Technology Evolution Department, Technology Reference Center and New Business Development Department. These three departments answer to the Technology and Network Quality Director.

The Technology Evolution Department has four people and its main function is technology research and forecasting. The Technology Reference Center has 20 people and is responsible for testing and approving new technologies and equipments. The New Business Development Department has seven people and plays a major role in the development of solutions, aiming to transform new investigated and tested technologies into products and services that will become part of the company´s portfolio.

In addition to the local research center, NETCOMPANY also has a global research center located in the parent company, which tests and investigates new technologies and informs the regional centers on their work. However, due to network, infrastructure and marker specificities in each country, subsidiaries have autonomy to prospect and test technologies more suitable to their own requirements. When the new technology reaches the development phase and requires significant investment, however, it is necessary to have headquarters´ approval.

• Technology Strategy Formulation in NETCOMPANY

Definitions and premises for technology research start from the future vision presented by the Marketing area in annual meetings involving Technology Evolution, Technology Reference Center, New Business Development and Engineering. In these meetings, Marketing presents its proposed roadmap for the products and services portfolio. In order to generate this roadmap and portfolio plans, Marketing is responsible for analyzing market tendencies, client demands, competitor analyses and suppliers´ new solutions.

After that, the R&D areas use premises agreed upon in these meetings to look for technological solutions that can be used to reach Marketing demands.

NETCOMPANY does not have a formal process for research and development. However, an informal process is followed, covering these steps and responsibilities:

- Available technologies research – Technology Evolution Department;
- Knowledge of the technology - Technology Evolution Department;
- Technologies testing – Technological Reference Center;
- Adherence to Marketing roadmap and products evaluation – Technology Evolution Department;
- Installed network adaptation requirements – Engineering;
- New product development – New Business Development.

The planned future has a two-year horizon. According to the interviewers, it is not a longer-term plan due to the dynamic nature of the industry and the high emergence rate of new technologies. This planning is described in a document called “Goal Network”. The objective of this document is to describe technologies that will be prospected and tested in the next two years according to the premises presented by Marketing and aligned with headquarters’ technological planning.

Technology strategy planning for the parent company is defined through a document called "Future Network" in which are referenced all technologies that must be used in the next two years by companies in the group. Subsidiaries are not involved in this planning process. The "Future Network" contains generic guidelines, and each subsidiary has a high degree of liberty to elaborate its own planning.

The Brazilian subsidiary´s Technology Reference Center is located inside a public university. However, there are no projects being developed in collaboration with this university. Currently, NETCOMPANY has a partnership with CPqD (a Brazilian telecom research center) for training technical staff and is in negotiation with a private university to develop a partnership for some research projects.

The main challenge faced by R&D teams in NETCOMPANY is to define which technology will be adopted in their products. The telecom market is booming. New technologies are launched constantly, quickly making old ones obsolete. It's a challenge to know ahead of time what the best technology will be for the company, considering the adaptation to new products and the future reduction in costs due to a large scale adoption. Considering technology availability and its effective use in new products, the maturation time ranges from two to three years, requiring a high level of investment.

In order to mitigate risks in selecting a new technology, some premises are used:

- Compliance with Marketing guidelines: R&D prioritizes technologies which adhere more closely to the proposed roadmap for products;
- Technologies offered by many suppliers: whenever possible, NETCOMPANY prioritizes technologies defined in global standards and avoids proprietary technologies;
- Prioritize technologies that can be used on a large scale, aiming at a unitary cost reduction in equipment acquisition or production;
- Prioritize Technologies defined in the "Future Network" document, when there is a definition.

Next, we move to the discussion of the propositions.

6.3. Discussion

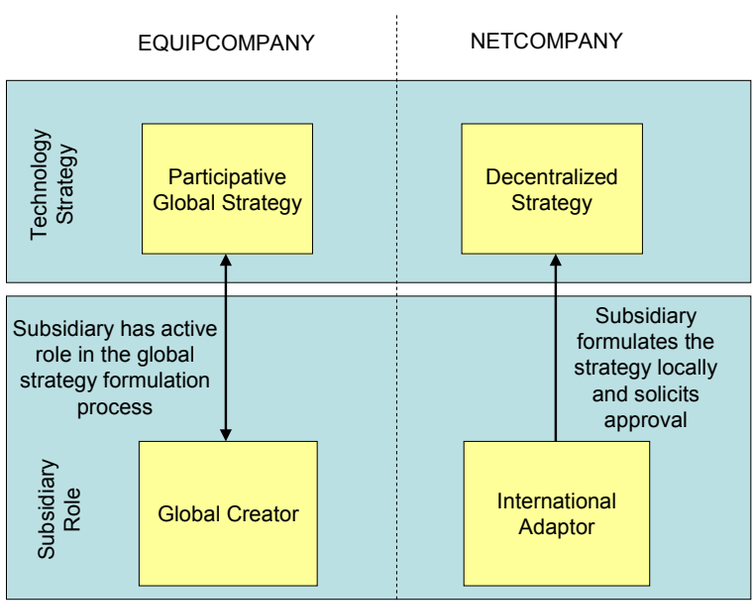
The first proposition was confirmed only in EQUIPCOMPANY, in which strategic workshops with representatives from almost all subsidiaries and departments establish a five-year scenario and main technological and corporate strategies. On the other hand, in NETCOMPANY, the technological strategy is a consequence of the corporate strategy; more specifically, it is derived from the market vision of the future. The process of technology strategy formulation proposed by Chiesa (1998) better explains the way EQUIPCOMPANY establishes its strategy. NETCOMPANY, on the other hand, does not have a formal process.

Developing dynamic capabilities (Teece et al., 1997) can seem especially important for equipment companies whose determined path creates path dependency (Barney, 1991; Dierickx and Cool, 1989), and therefore limiting its technological options in the future, and on the other

hand, creating barriers to imitation. The companies in this layer deal with developments that demand a long time period to be completed. They also need to disseminate their vision of the future among clients (network companies) to convince them to adopt their technology. This phenomenon points to the increased importance of developing the capacity to identify future opportunities, thus blurring the dividing line between technology strategy and corporate strategy. The network layer, however, doesn't develop, but applies new technologies developed by the equipment layer, which is simpler and less time-consuming. Because of this, they can wait and postpone the adoption of these new technologies until they have a clearer view of the dominant patterns emerging. Path dependency in the network layer appears to be less critical than in the equipment layer. Marketing, because it monitors market and consumer tendencies, appears to be the area that can best identify the ideal time to offer new products/services that will demand new technologies.

The second proposition was confirmed only in EQUIPCOMPANY, in which subsidiaries have a role as global creators. In NETCOMPANY, however, subsidiaries have a role as international adaptors. As was discussed, we adopted Nobel and Birkinshaw's (1998) classification typology on subsidiary involvement in the innovation process in order to discuss specifically their involvement in technology formulation strategy. The adopted typology is quite well adjusted to the context, but this research allowed us to identify another important dimension of the strategy formulation that has to do with decision-making power in the elaboration of strategy to be adopted. In the researched cases, EQUIPCOMPANY participated in the technology formulation strategy, as did NETCOMPANY, in a decentralized process. In addition to these two approaches, there may be cases of companies with an authoritarian process in which the headquarters dictates the technology guidelines to be adopted by the subsidiaries. Figure 2 illustrates this relationship between subsidiary and parent company in the process of formulating the technology strategy.

Figure 2: Subsidiaries´ role in the process of formulating the technology strategy



This research confirms other studies that found a more innovative capability in the equipment layer (Fransman, 2002; Galina & Sbragia, 2004; Cunha, 2009).

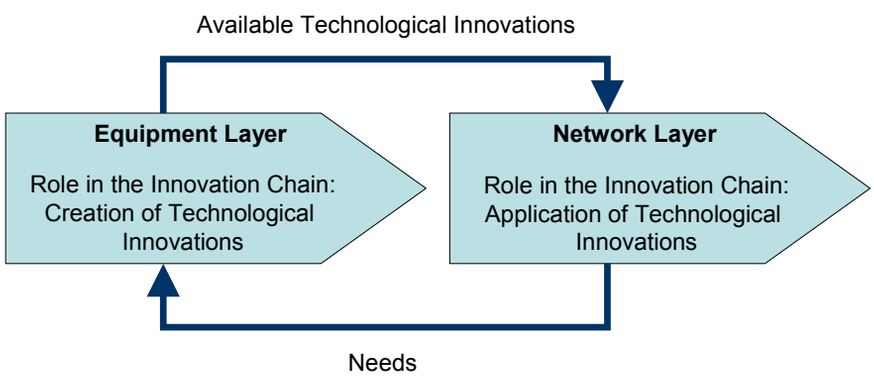
Table 3 summarizes the main differences between the two studied companies according to the propositions of this study identified in the review of the literature.

Figure 3: Technology Strategy Formulation – comparison between the two companies

Theoretical Constructs	Propositions	EQUIPCOMPANY	NETCOMPANY
Dynamic capabilities explains the competitive advantage of companies in high tech industries. The technological strategy is not a consequence of the corporate strategy, in the sense that they are interrelated and their limits are not clear. In high technology industries a company must reconfigure its resources dynamically to address a rapidly and constantly changing environment. (Teece, Pisano and Shuen, 1995; Chiesa, 1998). According to Chiesa (1998), the technology strategy formulation process comprehends external and internal analysis, identification of future distinctive technological skill base and strategic programming.	Proposition 1: the technology strategy and the corporate strategy are formulated in conjunction, stemming from the company's vision of the future.	Corporate strategy and technology strategy are formulated in conjunction. Twice a year a group of 300 persons is put together to review and define the vision for the next five years. External and internal analysis are carried out continuously by the research area and "heads" of technology with regular meetings for alignment; identification of future distinctive technological skill base; workshops for strategic discussion and future vision definition; strategic programming planned with roadmaps developed by the research area.	Technology strategy is a consequence of the marketing vision, which is a consequence of the corporate strategy. NETCOMPANY has a vision for two years ahead. There is no formal process for formulating the technology strategy. There are annual meetings coordinated by the marketing area to show its future vision and the desired roadmap for the services and technologies. Projects arise from marketing demands and new technologies offered by suppliers.
Involvement of subsidiaries in the technological innovation process: local adaptor, international adaptor and international creator (Nobel and Birkinshaw, 1998).	Proposition 2: multinational companies in high tech industries have a global technology strategy which is formulated with the involvement of subsidiaries. R&D units in subsidiaries have the role of international creator.	The Brazilian subsidiary has the role of "International Creator" and participates in global projects. All subsidiaries have an active role in the identification of opportunities and in the process of formulating a global technology strategy. Through a web portal, employees from different countries may interact and contribute to the innovation process.	The Brazilian subsidiary has the role of "International Adaptor", testing, homologating and implementing innovations to the local operation, but whose directions are not necessarily established by the parent company. The parent company must approve projects, but does not interfere in the local technology strategy formulation. Local innovations may be transferred to other subsidiaries, but always through the parent company. Subsidiaries do not collaborate in innovation projects.

This research also allowed us to verify some aspects that were not included in the original propositions, but are valuable for discussion and future research. The first one is the interdependence between the two companies for creation and adoption of innovations. Companies in the equipment layer create technological innovations and expend a lot of effort to convince the network layer to adopt them. In addition, companies in the network layer give valuable information about their future plans to subsidize the innovation process of companies in the equipment layer. Figure 3 shows this relation.

Figure 3: Relation between equipment and network layers in the innovation process



It was also possible to verify a different emphasis in the type of innovations developed by both companies. EQUIPCOMPANY has a strong focus on radical innovations, maintaining teams and facilities to create and develop new products. On the other hand, NETCOMPANY has a strong tendency towards the development of incremental innovations for improvement of operational processes, aiming at cost cutting and improvement in the quality of service.

Next, we move to our final considerations.

7. Conclusion

In this paper we investigated the process of formulating the technology strategy in Brazilian subsidiaries of global telecom industry companies. Based on the review of the bibliography, we formulated two propositions to guide the case study. One contribution of this study is the investigation of two aspects that were studied separately in the past: the technology strategy formulation and the role of the subsidiaries.

As we have already discussed, this study has some limitations. Like any case study, it cannot be generalized. The sample size and the number of interviews is also another limitation, but it was a consequence of the time frame for finishing the research and of the availability of the companies and individuals for an in-depth academic study. However, the case study methodology allows empirical verification of theoretical constructs, in order to improve them and maybe to contribute to new theory building (Eisenhardt, 1989; Yin 1989).

A big difference was observed in the way the two companies formulate their technological strategies. The two propositions could be verified only in EQUIPCOMPANY, in which technology strategy and corporate strategy are conjointly formulated and the Brazilian subsidiary has the role of "International Creator". In NETCOMPANY, the technology strategy is derived from the marketing strategy, and the Brazilian subsidiary has the role of "International Adaptor".

The study suggests that the development of dynamic capabilities (Teece et al., 1997) appears to be important for companies in the network layer, partly because of being involved in the development of products that require more time and accumulated knowledge, creating path dependency (Barney, 1991; Dierickx and Cool, 1989). The equipment layer applies network layer innovations, which require large investments, but less development time and fewer restrictions because of past decisions on development of abilities. EQUIPCOMPANY, then, must innovate and disseminate its vision of the future to its potential clients (network layer companies) in an attempt to influence the industry's technological evolution and consolidate its vision of the future. NETCOMPANY, on the other hand, needs to innovate, but with attention to making correct decisions on technologies that will have wide acceptance, product variety and slower obsolescence.

The technology formulation strategy used by EQUIPCOMPANY has the main advantage of aligning subsidiaries around a common vision and of creating synergy among them, as they are stimulated to collaborate on global projects. In contrast, the subsidiaries' autonomy to create innovations highly adapted to a particular country is limited. However, the approach to technology strategy formlation used by NETCOMPANY streamlines decision-making and allows the subsidiaries to create innovations which are highly adapted to specific local needs. On the downside, we can highlight the problem of coordination among the subsidiaries, possible duplication of work and investment, and lack of synergy and collaboration on innovation projects.

This paper also opens many opportunities for future research. The same study could be applied to a larger sample involving firms from other technology-intensive segments. Another possibility is quantitative research to investigate the role of subsidiaries in technology strategy formulation in order to determine whether different configurations could lead to better innovative performance. A longitudinal study can also be done to examine how the role of subsidiaries in the innovation process is changing over time.

References

Acedo, F.; Barroso, C.; Galan, J. L. (2006), "The Resource-Based Theory: Dissemination and Main Trends", Strategic Management Journal, Vol. 27, Num. 7, pp. 621-636.

Arasti, M.; Packniat, M. (2006), "A Classification of Models for Technology Strategy Formulation", II EUROMOT - European Conference on Management of Technology, Birmingham, England.

Barney, J. (1991), "Firm Resources a Sustained Competitive Advantage", Journal of Management, Vol. 17, Num. 1, pp. 99-120.

Blanc, H.; Sierra, C. (1999), "The internationalisation of R&D by multinationals: a trade-off between external and internal proximity", Cambridge Journal of Economics, Vol. 23, Num. 2, pp. 187-206.

Bone, S.; Saxon, T. (2000), "Developing Effective Technology Strategies", Research Tecnology Management, Vol. 43, Num. 4, pp. 50-58.

Bonoma, T. V. (1985), "Case Research in Marketing: Opportunities, Problems, and a Process", Journal of Marketing Research, Vol. 22, Num. 2, pp. 199-208.

Chiesa, V. (1996), "Strategies for Global R&D", Research Technology Management, Vol. 39, Num. 5, pp. 19-25.

Chiesa, V.; Mazini, R. (1998), "Towards a Framework for Dynamic Technology Strategy", Technology Analysis & Strategic Management, Vol. 10, Num. 1, pp. 111-129.

Cunha, A. (2009), "Convergence and Innovation in Telecommunication Services: An Assessment From The Perspective Of The Complementary Assets and Dynamic Capabilities Theories", International Journal of Innovation and Technology Management, Vol. 6, Num. 1, pp. 41-58.

Eisenhardt, K. (1989), "Building Theories from Case Study Research", Academy of Management Review, Vol. 14, Num. 4, pp. 532-550.

Eisenhardt, K.; Martin, J. (2000), "Dynamic capabilities: what are they?", Strategic Management Journal, Vol. 21, Num. 10/11, pp. 1105-1121.

Fransman, M. (2002), "Mapping the evolving telecoms industry:the uses and shortcomings of the layer model", Telecommunications Policy, Vol. 26, pp. 473-483.

Galina, S.; Sbragia, R. (2004), "Comportamento Empresarial Tecnológico: Alguns Indicadores no Setor de Telecomunicações", In: Sbragia, R.; Galina, S. (Eds), Gestão da Inovação no Setor de Telecomunicações, PGT/USP, São Paulo, Brasil.

Ghoshal, S.; Bartlett, C. (1988), "Creation, Adoption, and Diffusion of Innovations by Subsidiaries of Multinational Corporations", Journal of International Business Studies, Vol. 19, Num. 3, pp. 365-388.

Gassmann, O.; Zedtwitz, M. (1998), "Organization of Industrial R&D on a Global Scale", R&D Management, Vol. 28, Num. 3, pp. 147-161.

Hoskisson, R.; Hitt, M.; Wan, W.; Yiu, D. (1999), "Theory and research in strategic management: swings of a pendulum", Journal of Management, Vol. 25, Num. 3, pp. 417-456.

Nobel, R.; Birkinshaw, J. (1998), "Innovation in Multinational Corporations: Control and Communication Patterns in International R&D Operations", Strategic Management Journal, Vol. 19, Num. 5, pp. 479-496.

Patel, P.; Pavitt, K. (1997), "The Technological Competencies of the World's Largest Firms: complex and path-dependent, but not much variety", Research Policy, Vol. 26, Num. 2, pp. 141-156.

Pavitt, K. (1984), "Sectoral patterns of technical change: Towards a taxonomy and a theory", Research Policy, Vol. 13, Num. 6, pp. 343-373.

Pearce, R. (1999), "Decentralised R&D and strategic competitiveness: globalised approaches to generation and use of technology in multinational enterprises (MNEs)", Research Policy, Vol. 28, Num. 2-3, pp. 157-178.

Porter, M. (1980), "Competitive Strategy", Free Press, New York.

Prahalad, C. K.; HAMEL, G. (1990), "The Core Competence of the Corporation", Harvard Business Review, Vol. 68, Num. 3, pp. 79-91.

Roussel, Philip et al. (1991), "Third Generation R&D", Harvard Business School Press, Boston.

Singh, J. (2008), "Distributed R&D, cross-regional knowledge integration and quality of innovative output", Research Policy, Vol. 37, Num. 1, pp. 77-96.

Subramanian, M.; Venkatraman, N. (2001), "Determinants of Transnational New Product Development Capability: Testing the Influence of Transferring and Deploying Tacit Overseas Knowledge", Strategic Management Journal, Vol. 22, Num. 4, pp. 359-378.

Teece, D.; Pisano, G.; Shuen, A. (1997), "Dynamic Capabilities and Strategic Management", Strategic Management Journal, Vol. 18, Num. 7, pp. 509-533.

Vasconcellos, E. P. G.; Monterossi, J. O. ; Bruno, M. A. C. (2007), "Identification of Technological Threats and Opportunities: Conceptual Framework and Application in an Autoparts Company", In: 16th International Conference on Management of Technology, Florida: IAMOT.

Wernerfelt, B. (1984), "A resource-based view of the firm", Strategic Management Journal, Vol. 5, Num. 2, pp. 171-180.

Yin, R. K. (1989), "Case Study Research. Design and Methods", Sage Publications, California.