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Analysis of technological innovation strategy for small and medium companies of the aeronautical sector

Abstract: *The inherent risk in high-tech activity requires the construction of technological strategies that serve global strategy of the company. The present study aimed to characterize the technological position of small and medium technology-based companies of the aeronautical sector located in the Vale do Paraíba, and to examine whether these companies have a technological strategy formalized and disseminated. The adopted methodology was a descriptive exploratory research, carried out through in-depth individual interviews conducted with the small e medium company's owners of the cities of Caçapava, São José dos Campos and Taubaté, Brazil. The authors concluded that it is necessary that companies, especially small and medium-sized, adopt a technological innovation strategy integrated with the company's overall strategy. This will help keeping them competitive within their specificities, and not only in the domestic market, but also in international markets.*

Keywords: *Strategy, Technological innovation, Technological strategy, Small and medium technology-based companies.*

INTRODUCTION

The increase in the speed of technological change and globalization have turned technological innovation into something that is vital to the business survival and growth.

According to Moraes *et al.* (2009a), in an environment that is more dynamic, competitive and increasingly complex, the strategies, represented by business decisions and actions that guide the organization in the search for success and technological innovation, playing a fundamental role in the life of technology-based companies, have become much more important and, at the same time, much more difficult to set and implement.

In this sense, Clark and Wheelwright (1993) observed that in most industries of Japan, Europe or the United States, executives recognized that the development area of new products and processes (innovation) offers the greatest opportunities and that companies need to develop their capabilities. In other words, innovation, especially technology, is recognized as a major source of competitive advantage.

Another important point is technological strategy, which becomes a central ingredient in the concept of company, and technology now represents one of the basis of strategic planning, guiding the fundamental question

of how to establish a competitive advantage and how to ensure the survival of the company (Moraes *et al.*, 2009a).

Decide what future you want for the company, which technological strategy you have to follow to ensure this future, how to create and develop a climate which is favorable to innovation, which level of resources to allocate and how to develop this activity inside the corporation and in the market; this is one of the most complex and critical set of decisions that small and big companies have to face. An appropriate answer to these questions can ensure competitiveness and sustainability to these companies.

Thereby, with the perspective of deepening the comprehension of this synthesis – strategy, innovation and technology – and the question of its application in small and medium technology-based companies, the matter of this research was formulated as follows: How can a strategic program, aimed at technological innovation, leverage the segment of small and medium firms in the Paraíba Paulista Valley?

Within this context, the research proposal relates to the characterization of the technological position of small and medium technology-based companies of the Aeronautical sector located in the Paraíba Paulista Valley, and to examine whether these companies have a technological strategy formalized and disseminated.

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THEORETICAL REFERENTIAL

This section constitutes a literature review of existing ideas about small and medium technology-based companies, the Brazilian Aeronautical Industry, Technological Innovation and Technological Strategy.

This approach aims to establish how the relationship is developed between the mentioned areas.

Small and medium technology-based companies

The technology-based companies play an important role in the economic and social development of the country, contributing to innovation in products of high market potential, besides creating qualified jobs, stimulating the process of science and technology and narrow the relations between various bodies and sectors of the economy.

For a better understanding of what a technology-base company is, it is necessary to characterize the concept of technology-based. The *Associação Catarinense de Empresas de Tecnologia* (ACATE, 2008) divides the technology-based into two topics:

- process or product that results from scientific research and whose aggregate value comes from the areas of advanced technology such as computers, biotechnology, fine chemicals, new materials, mechanics of precision, among others;
- application of scientific knowledge on complex techniques and on the high technical qualification work.

The concept of technology-based is founded on these two points, implementation of scientific research and applying this knowledge to develop new technologies (Berté, 2006). Valério Netto (2006, p. 3-4) defines the technology-based companies as those “that adopt new technologies in their production process, including both manufacturing companies as services companies with high content of knowledge”.

The *Associação Nacional de Entidades Promotoras de Empreendimentos Inovadores* (ANPROTEC) defines a technology-based company as an enterprise that support the productive activity in the development of new products and processes, based on the systematic application of scientific and technological knowledge and on the use of advanced and pioneering techniques (ANPROTEC, 2002). Technological innovation is, therefore, one of the benefits that technology provide to the market.

Beaver and Prince (2004) argue that the definition and classification of small and medium technology-based companies is very complex. In Brazil, there is not a specific concept for these companies, so they are defined in a general concept which is associated with their size and not with their established activity, based on quantitative and qualitative criteria.

The quantitative criterion is divided into two sub criteria:

- by number of employees, criterion adopted by Sebrae (*Serviço de Apoio às Micro e Pequenas Empresas*), accordingly to the Status of Micro and Small Enterprise;
- the gross operating revenue according to the Brazilian Development Bank (BNDES) and indicates the operational and accounting movement of the firms.

Leone (1991) states that the first criterion is both economical and social, because it offers indications of social problems related to the absorption of labor, level of income and productivity. About the second criteria, the author emphasizes that though it reflects the size of the market of the companies, it is vulnerable, because it may vary according to the fluctuation of the currency or changes in accounting criteria.

The Table 1 details the criteria for classification by number of employees and by annual gross operating revenue.

The quantitative criterion is important, because companies, according to their size, can often enjoy the benefits and

Table 1: Criteria for classification of micro, small and medium companies in Brazil

Institution	Criteria for classification					
	Industry			Trade and services		
	Micro	Small	Medium	Micro	Small	Medium
Sebrae	Until 19 employees	20 to 99 employees	100 to 499 employees	Until 9 employees	10 to 49 employees	50 to 99 employees
BNDES	Until R\$ 1,2 million	More than R\$ 1,2 million and less than R\$ 10,5 million	More than R\$ 10,5 million and less than R\$ 60 million	Until R\$ 1,2 million	More than R\$ 1,2 million and less than R\$ 10,5 million	More than R\$ 10,5 million and less than R\$ 60 million

Source: Sebrae (2007) and BNDES (2008).

incentives provided by the Brazilian Legislation based on public policies (Berté, 2006). These policies aim at: increasing exports, generating employment and income and reducing informality of small and medium businesses.

The qualitative criterion refers to the internal structure of the company, as well as the organization and management style (Berté, 2006). In this manner, a more accurate vision of the company is provided, that is, it is related to the direction styles, the profiles and attitudes of leaders and their perception of the environment.

Leone (1991) explains that while the quantitative criterion provides a static image to the company, the qualitative criterion appear to offer a vision of movement, more action from management, in other words, it describes the operation of the company, the movements of staff, material resources and operations with suppliers and customers.

Finally, the importance of small and medium technology-based companies to regional development occurs through the economic and social benefits that they provide to their region, especially in terms of process of industrialization, search for competitiveness and technological development (Berté, 2006).

The Brazilian aeronautical industry: a historical overview

In Brazil, the effort to create the basis of aeronautical and aerospace sector reaches 1945, when the Ministry of Aeronautics, created on January 21st, 1942, by law n° 2961, designed and implemented the Aerospace Technological Center (CTA). On January 16th, 1950, CTA was running his engineering school, the Aeronautical Technology Institute (ITA), as the first class of ITA began their studies in 1947 in São José dos Campos (Lima *et al.*, 2005).

According to Rodrigues (2008), the city of São José dos Campos was chosen as the appropriate location for the installation of CTA due to some factors such as: location on the banks of the old road Rio – São Paulo (nowadays, called *President Eurico Gaspar Dutra* Road – Via Dutra), topographical features and climatic conditions favorable to aviation, easiness of obtaining energy, proper distance from urban centers, proximity to the Port of São Sebastião and access to the medium and large-size industries installed in the surroundings of São Paulo city.

Therefore, the creation of the Research and Development Institute in CTA, in 1954, reinforced the strategy of acquiring knowledge and self-sufficiency in key areas of the aeronautical industry, namely: aircraft design, electronics, materials, engines and flight tests (Lima *et al.*, 2005).

Within this context, one can say that the center of this coordinated strategy has always been the target of this national capacity in the technological and industrial sectors.

In October 1954, the Brazilian Aeronautics Industry started with the foundation of the Neiva Aeronautics Building Society, installed in the Manginhos Airport, Rio de Janeiro. In 1960, the company opened an office in São José dos Campos, nearby CTA, aiming to increase research and development of aircraft (Rodrigues, 2008).

Amato Neto and Santos (2005) argue that in spite of the effort for aviation, training bases have been founded in the 1940, being intensified in 1960, with the industry knowledge generated by the laboratories of CTA and added to other studies on engineering of other institutions. This fact allowed the suitability of products with world class standard in the sector.

President Arthur da Costa e Silva, in August 19th 1969, under the leadership of Minister of Aeronautics, created the Embraer (*Empresa Brasileira de Aeronáutica S.A.*), a private and public capital entity intended for serial manufacturing of aircraft (Rodrigues, 2008).

According to Lima *et al.* (2005), Embraer is the main productive and technological core of the Brazilian industry, articulating a set of micro, small and medium supply companies around their economic activities.

The aeronautical industry has had its development, especially with regard to Embraer, due to the incentives given by the government at the time of its creation (Silva, 2005). The author emphasized that the incentive was a concession by the militaries, from the donation of land in prime location to the required basic infrastructure, which was transferred from the Research and Development Institute directly to Embraer.

Finally, the aerospace industry in Brazil is expected to reach the turnover of US\$ 7.8 billion with the occupation of 27 thousand jobs in 2010 (Moraes *et al.*, 2009b). To achieve these estimates, it is necessary to invest in the strengthening of small and medium companies of the aerospace sector (Bartels, 2003 *apud* Amato Neto and Santos, 2005).

The city of São José dos Campos has become an aerospace pole due to its topographic conditions, climate and location. The city received federal investments and struggled for the implementation of this sector (Moraes *et al.*, 2009b).

Technological innovation

In recent decades, the production systems have changed its organizational structures according to the market and

environment in which they are inserted. In this process of changes, new technology of product and process are being introduced in the companies (Predrassoli, Silva and Ferreira, 2001), which has enabled the development of technological innovations.

Technological innovation consists of an essential tool to increase the productivity and competitiveness of organizations, as well as to boost the regional development. For Tigre (2006), the development does not originate a simple growth of the existing economic activities, but rather reside fundamentally in a qualitative process of transformation of production structure to incorporate new products and processes and aggregate values to production through the intensification of the use of information and knowledge.

The Frascati Manual (OCDE, 2002) defines innovation as the transformation of an idea into a new product, or into the improvement of a product that is introduced in the market, or new production systems and its diffusion, commercialization and utilization. According to Sáenz and García Capote (2002), the expression technology can be understood as a set of scientific and empirical knowledge, skills, experience and organization required to produce, distribute, commercialize and use goods and services.

In this manner, it is possible to correlate technological innovation to the transformation of knowledge into products, processes and services that can be put on the market (Mattos and Guimarães, 2005).

It is important to emphasize that the origin of the concept of innovation can be credited to Joseph Schumpeter, when he made the conceptual distinction between invention and innovation. While the invention is related to the creation of a process, technique or new and inedited product, the innovation is associated with the process of creating a commercial product from an invention, in other words, involves both invention and commercialization (Schumpeter, 1982).

In the vision of Schumpeter (1982), innovation is a set of new upgradeable functions that change the methods of production, creating new forms to organize work and to produce new products, also enabling the opening of new markets by creating new uses and consumption.

The innovation that gives rise to the process and economic development or economic progress is the fundamental phenomenon of capitalist life, in other words, the capacity to generate innovation is the result of accumulation of technical and economic competences for survival and growth of companies in a certain country (Hiratuka, 1997).

Schumpeter (1982) explains that the economic development is the result of “spontaneous and discontinuous changes”, that is, the producer starts the economic change and the consumers are ‘taught’ to want newness or things that differ in any aspect from those that they habitually use or buy.

The author also emphasizes that the new combinations of productive resources or innovations in the development process include five alternatives (Schumpeter, 1982):

- **Introduction of a new good** – a good that consumers are not familiar with yet;
- **Introduction of a new method of production** – a method that has never been tested in the field of transformation industry, which in any way must be based on a original scientific discovery, and may also consist of a new way of commercially handling a commodity;
- **Opening of a new market (market innovation)** – a market in which the particular branch of processing industry of the country concerned have not entered yet, whether this market existed before or not;
- **Achievement of a new source of raw material supply of or intermediate input (input innovation)** – again, regardless of the fact that this source already exists or had to be created; and,
- **Carrying out of a new industry organization (organizational innovation)** – creating a monopolist position or the fragmentation of monopolist position.

In summary, Schumpeter tries to explain how the circular flow is broken by the activation of the transformation capacity of the capitalist system, providing opportunities for economic expansion and for the economic cycle.

Other important aspects for innovation are the technological changes. For Tigre (2006), these changes are differentiated by its degree of innovation and the extension of changes in relation to existing. The range of innovations observed in the economic activity is classified by Freeman and Soete (1997), as depicted in Table 2, according to its impacts.

Finally, the innovation has been a main target for success not only to large-sized companies, as seen until 1997, but also for small and medium companies of various sectors (Tidd, Bessant and Pavitt, 2001).

Table 2: Taxonomy of technological change

Type of technological change	Character
Incremental	Daily improvement and changes.
Radical	Discontinuous jumps in products and process technology.
New technological system	Achieving changes that affect more than one sector and give rise to new economic activities.
New technical and economical paradigm	Changes that affect the whole economy involving technical and organizational changes by changing products and processes, creating new industries and establishing trajectories of innovations for decades.

Source: Freeman and Soete (1997).

Technological strategy

The technological strategy, as explains Coutinho (2004), becomes a central factor in the concept of company, and technology constitute a basis for strategic planning, guiding the fundamental question of how to establish a competitive advantage and how to ensure the survival of the firm.

According to Morone (1989), the technology creates strategic opportunities; the innovative companies recognize these opportunities and build corporate strategy around them. Then, one can state that the strategy creates the technological needs.

Coutinho (2004) argues that business and technology strategies are increasingly interdependent. However, the current dynamic of industry competition, the difficulty in identifying the potential impact of new technologies and the fact that the benefits of these technologies are not immediately quantifiable hinder this integration.

Narayanan (2001) states that the concept of technological strategy has emerged in the period post World War II, when companies such as Westinghouse and General Electric sought to diversify through the efforts of R&D. From the recognition that technology was determining the competitiveness of technology-intensive industry, researchers and managers began to incorporate this dimension in business strategy (Coutinho, 2004).

A paper presented by Prahalad, in 1974, identified the fundamental question that came to dominate further work in the area: "Is the conception of a technological

strategy for the company realistic?" (*apud* Kantrow, 1980). Rosenbloom (1978) answers this question with an emphatic "yes". According to the authors, the concept of a technological strategy permits to build an integrated framework that is able to insert a technology of a company in the context of their business.

Kantrow (1980) emphasizes that the studies carried out in the 1970s demonstrated the importance of technological decisions and its insertion in the context of strategic thoughts of companies. For Narayanan (2001), after this period, during the 1980s, the concept of technological strategy takes shape and begins to be idealized and developed.

Therefore, the subject of technological strategy became important as companies wised up the probability of using technology as a competitive weapon (Burgelman, Maidique and Wheelwright, 1995).

Friar and Horwitch (1985) argue that this awareness was due to the convergence of five historical forces: loss of faith in other basic strategies, apparent success of high-tech small companies, the priority given to technology by Japanese companies, increasing awareness of the potential contribution of manufacturing strategy and process technology to competitiveness.

According to Rieck and Dickson (1993), the term "technological strategy" is relatively new, as it was first mentioned in the literature on the beginning of the 1980s. Chiesa and Manzini (1998), the subject has attracted increasing attention, and models have been developed considering the technology as an input data in the process of strategy formulation, establishing a link between technological strategy and corporate and business strategies.

For Maidique and Patch (1988), the technological strategy includes policies and decisions that impact on the technological processes of the company. It involves choices between new technological alternatives, the criteria by which they are incorporated by new products, processes and distribution of resources that will enable its successful implementation.

Narayanan (2001) explains that the technological strategy is the pattern revealed in the technology choices of companies. The choices involve the commitment of resources to ownership, maintenance, exploitation and abandon of technological capabilities. These choices determine the character and extent of the main technical capabilities of the company and use the platform of processes and products available.

Finally, Freeman and Soete (1997) identified six alternatives of technological strategy that should be taken as a spectrum of possibilities. These six alternatives are:

- Companies may select one or more strategies in different segments of their activities and change it over time;
- The choice of strategy is linked to the objectives of their executives and shareholders;
- The companies may decide to use their technical, managerial and financial capacities to seek alternatives that maximize return on investments at short term or thinking about building a technological basis for the future;
- They may turn to alliances with different partners or act independently;
- They may acquire technological packages or start developing their own solutions; and,
- Such decisions depend on financial and human available resources, on the characteristics of the markets, on the technological dynamics and on the explicit or implicit strategy that the company decides to follow.

Technological positioning

Numerous researchers have been trying to characterize and codify the technological strategies of the companies. However, the difficulty in understanding how the companies deal with aspects related to their technological strategy caused many of them to look for help in specific techniques and methodologies (Coutinho, 2004).

There are several typologies for the strategic/technological positioning of the companies. These typologies are generally based on the time of entry of the product on the market (marketing), in innovation policy (technology), or the company' strategy posture in relation to the environment (competition).

For a better understanding, Nakano (1998) defines the typologies as special classifications that focus only one

or two attributes of the organization. The author also emphasizes that there is great predictive value, but focusing on one limited aspect or region of the company's behavior.

Analyzing Table 3, one perceives that the authors are not based on a statistical analysis of data; they rather use their experience and knowledge about the industry. Nakano (1998), Narayanan (2001) and Loewe, Williamson and Wood (2001) explain that the strategies postulated in the proposed typologies are actually used by companies.

In the typology presented by Ansoff and Stewart, in 1967, the strategies are based on the time when the product enters the market, in other words, they include strong marketing components (*apud* Nakano, 1998; Narayanan, 2001).

The first company of the market will benefit from advantages of operating a temporary monopoly. It requires a strong commitment for Research and Development (R&D), the establishment of a technical leadership besides presenting a high rate of risk (Nakano, 1998; Narayanan, 2001).

Following the leader or second on the market involves quick entry in growing markets based on the imitation of the pioneering innovations of direct competitors. The adoption of this strategy requires high development capacity (Nakano, 1998; Narayanan, 2001).

The strategy of engineering application or market segmentation comprises the focus on specific market niches. It requires strong ability in engineering application such as good flexibility in the production area (Nakano, 1998; Narayanan, 2001).

Adopting the strategy of "Me Too" or minimization of cost presupposes the capacity of obtaining relative advantages of cost through economies of scale, cost reductions from changes in process or product or by reducing overhead costs and controlling operating costs. It requires ability in product and process engineering (Nakano, 1998; Narayanan, 2001).

Table 3: Typologies for technological posture of the company

	Ansoff and Stuart (1967)	Miles and Snow (1978)	A. D. Little (1981)	Freeman and Soete (1997)
Technological strategy	• First on the market	• Defender	• Leader	• Offensive
	• Follow the leader or second on the market	• Prospector	• Follower	• Defensive
	• Engineering application and market segmentation	• Analytical	• Niche	• Imitator
	• "Me Too" or Minimization of Cost	• Reactive	• Rational	• Dependent
				• Traditional
				• Opportunist

Source: Adapted from Freeman and Soete (1997), Nakano (1998), Narayanan (2001) and Loewe, Williamson and Wood (2001).

The typology of Miles and Snow, formulated in 1978, is based on strategy posture of the company in relation to its environment, that is, it incorporates elements of competition in innovation policy (Nakano, 1998).

Companies with defensive strategy have a field of product and narrow market, seldom seeking new opportunities outside these limits. Profitability will come through the stability and efficiency (Nakano, 1998).

The prospectors continuously seek new products and markets. They are constantly changing, often spending an idea of inefficiency, but always remain as a powerful force in the market (Nakano, 1998).

The analytical companies combine aspects of defenders and prospectors. They put into action both stable form and changing. Reactive companies are slowly changing, unable or unwilling to change their fields of product and market. The change in their environment is noticed, but they can not accompany because there is not a consistent relationship between strategy and structure (Nakano, 1998).

The typology of A. D. Little is based on two dimensions: scope and leadership. Decisions on the scope refer to the way firms answer the question: "Which technologies should be explored?" The decisions concerning technological leadership are related to the commitment of the company to pro-activity, which is expressed, in many cases, as pioneerism (Narayanan, 2001).

The companies that are leaders in technology establish and maintain a competitive position through the development and exploitation of all technologies included in a certain market, providing a dominant position in this market (Narayanan, 2001).

The technology is an important factor for creating and maintaining the competitive advantages in these companies. They seek competitive advantage through technological appropriateness. They can board a non-pioneer position in many cases. Therefore, they know that the market will be waiting for their input. Then, they avoid the initial phase of undefined of product, searching on their competences the knowledge to introduce a superior product for the pioneers, making it obsolete (Narayanan, 2001).

The niche strategy is to focus on a limited number of critical technologies to seed the leadership. Technological Development is selective. Normally, it adopts the pioneering actions in order to take the market of the leader and build a pioneer reputation (Narayanan, 2001).

Follower companies have expertise in a wide range of technologies. Their strategy is based on exploration,

avoiding the risks involved in basic research. For these companies, technology is not a primary instrument in the search for competitive advantage. They aim at acquiring skills that support their business corporate strategy (Narayanan, 2001).

The Rational Companies comprehend those which possess knowledge in a selected group of technologies. For these companies, the technology deficit must be compensated by other competitive forces (Narayanan, 2001).

The typology proposed by Freeman and Soete (1997) is based on how the company deals with technology in their innovation policy. The offensive innovation strategy has the characteristic of obtaining technological and marketing leadership by introducing new products. Normally, it is intensive in R&D and involves fundamental research.

The defensive subject closely follows the leader and the technological change. The expense with R&D may be as high as those of the market leader, but a large portion of them seeks research application aiming to improve the products of competitors (Freman and Soete, 1997).

The imitator company is interested in mimicking the innovations brought to the market. The expenses with R&D are reduced and there is an emphasis on the development and reduction of production costs (Freman and Soete, 1997).

Companies with dependent strategy adopt reactive posture, promoting changes in products and processes only when requested by clients or headquarters. It is characterized by no expenses with R&D (Freman and Soete, 1997).

The traditional strategy is used by companies that are under pressure to change their products. Market and competition do not require any adjustment in the product. Research and development are nonexistent and production processes are well developed (Freman and Soete, 1997).

Finally, the opportunist company is constantly looking for opportunities in new markets while maintaining strict control over existing operations. The key to the success of this strategy is the control of costs and marketing innovations (Freman and Soete, 1997).

METHODOLOGY

This research adopted as methodology a formulation of exploratory descriptive research type, through individual in-depth interviews with owners of small and medium technology-based companies in the cities of Caçapava, São José dos Campos and Taubaté, Brazil.

Data collected in the interviews were analyzed using qualitative approach, which allowed a clear and detailed description on knowledge of technological innovation and technological strategy of the owners in the small and medium technology-based companies of aeronautics sector of Paraíba Paulista Valley.

Population and sample

Based on data collected from National Bank of Economic and Social Development (BNDES) (2007), currently, the cities Caçapava, São José dos Campos and Taubaté have an estimated population of 176 technology-based companies of small and medium size, in other words, these companies have annual gross operating revenue superior to R\$ 1,2 million and inferior to R\$ 60 million.

Triviños (1987) defines population or universe as the set of people so that specific part of the environment in which the search will be conducted.

The sample of this paper was probabilistic and finite, in other words, considering an estimated 5% error margin, 95% confidence interval and one-way variance, it had a sample of 36 small and medium technology-based companies. This number was obtained through the following equation (Spiegel, 1993):

$$Sample(n) = \frac{s^2 \cdot Z^2 \cdot N}{s^2 \cdot Z^2 + e^2 \cdot (N - 1)} \quad (1)$$

In which s^2 is the variance; N is the population; Z is the confidence interval; e is the margin of significance.

Marconi and Lakatos (2000, p. 42) define sample as “a portion and parcel, conveniently selected from the universe (population)”. In other words, is a subset of the studied population that shows certain characteristics in common.

ANALYSIS OF THE RESULTS

In Brazil, the domestic market is conservative and presents difficulty in introducing new features. It reduces the interest of companies in innovate, making them act only reactively, when there is the possibility of loss of market.

Therefore, it is postulated in this section that there are business and technology strategies and postures that small and medium technology-based companies of the aeronautical sector in Caçapava, São José dos Campos and Taubaté can adopt in order to remain competitive within their specificities and not only in the domestic market but also internationally.

According to technological strategic positioning of small and medium technology-based companies

The present proposal of technological positioning assessment for small and medium technology-based companies takes as its starting point the analysis and proposals of Freeman and Soete (1997). For these authors, the technological strategy is based on the way that the company addresses the technology in its innovation policy.

The privileged approach in this study has the innovation as purpose. The midpoint is to question the aptitudes that a company must initially hold so that the innovation occurs and be profitable. This conception is consistent with the proposal of Nelson and Winter (1982) which postulates the existence of routines to innovate on the basis of companies' performance in dynamic competitive environments.

To obtain this result, the study was initiated by analyzing a questionnaire on technological positioning which was applied to the owners of small and medium technology-based companies of aeronautics sector located in Caçapava, São José dos Campos and Taubaté.

The Figure 1 shows the values in percentages obtained by the companies analyzed for each strategic/technological positioning. It was noted that 61% of small and medium technology-based companies of the aeronautical sector located in Caçapava, São José dos Campos and Taubaté are proactive followers, in other words, they adopt a defensive posture.

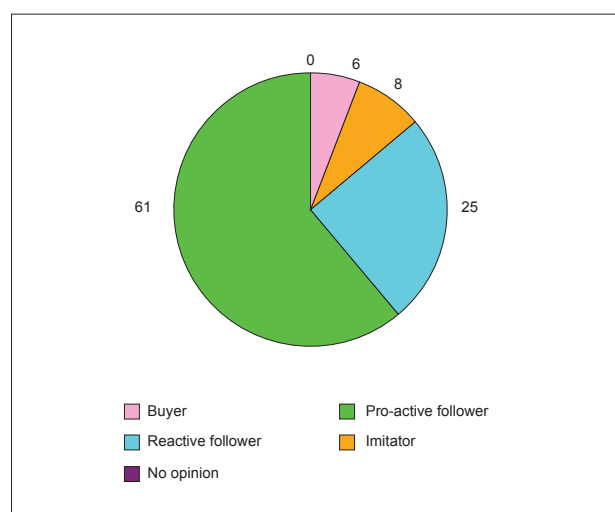


Figure 1: Strategic positioning.

According to Freeman and Soete (1997), the defensive strategy shows that companies are closely following the leader and the technological changes. Expenses with R&D can be as high as those of the market leader, but a

large portion of them seek research application aiming to improve the products of competitors.

The interviewees reported, in general, that the firms differentiate their products from the knowledge of the client's business, that is, these companies have a product domain and a closed market, so they rarely look for new opportunities extrapolating these limits.

We also checked that the reduction in the life cycle of products is leading to a decrease in the range of opportunities. The interviewees argue that the current age of discontinuity becomes difficult to survival of small and medium companies, which do not respond quickly to technological changes. From this perspective, one can say that the proactive followers companies have to be fast enough to ensure and increase the market share.

Following, the reactive followers companies appear. Note that 25% of these companies promote changes in products and processes only when requested by customers or arrays, which means that they have a dependent strategy. It was also checked that these companies have reduced expenses with R&D and there is an emphasis on the development and reduction of production costs.

The imitator's posture is characterized by identifying the opportunities and copying the innovations brought to the market. It was noted that 8% of companies do not have expenditures with R&D.

It was observed that 6% of the analyzed companies are characterized by being buyers of technology, in other words, Research and Development are nonexistent and the production processes are very developed.

After the interviews, we found that imitators and buyer companies work with mature processes and products. They seek to minimize the operating cost (production, overheads and others), having scale and automation as main sources of competitive advantages.

Finally, it was found that small and medium companies of the aeronautical sector of the cities of Caçapava, São José dos Campos and Taubaté do not have an offensive technological posture. One can say that the leadership companies are aimed to radical innovation, that is, bringing ideas, products and/or processes completely original to the market.

According to business and technological strategies

It is possible to say that there is no agreement on the definition and wide-ranging of what a technological strategy is, which makes it difficult to assess its contribution as a source of

competitive advantage. It is difficult to identify clear and measurable objectives for the technological strategy.

According to Afuah and Utterback (1997), technological evolution requires different strategy for each phase of the life cycle of a product. The cumulative and differentiated nature of technological development in companies suggests that the dimensions used do not have to include and consider a variety of sources of technological opportunities and the different speeds and directions of their developments.

These two aspects comprise the interfaces between technological, productive and organizational dimensions, making it difficult to identify which of them are representative and may account for performance gains in the company.

The present proposal of assessment with small and medium technology-based companies of the aeronautical sector in Caçapava, São José dos Campos and Taubaté aims to identify how business and technological strategies are formalized and disseminated in the company.

The Figure 2 shows the values in percentages obtained by the analyzed companies concerning the formalization and dissemination of business strategy. Analyzing the presented data, it was observed that 47% of the companies report having an informal business strategy, that is, they have an explicit business strategy, but it is restricted in some levels of management.

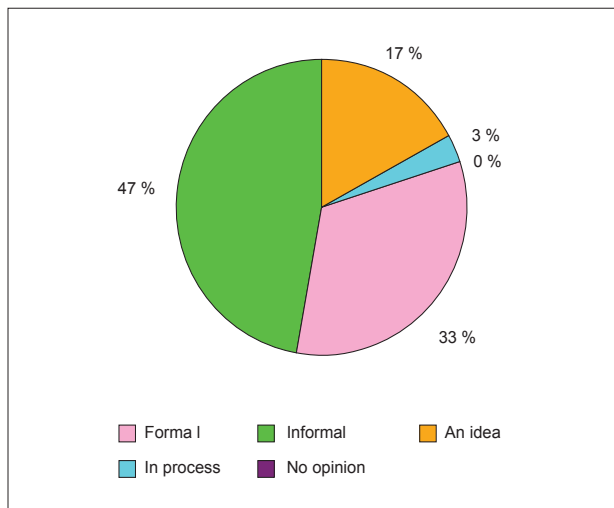


Figure 2: Business strategy.

The interviewees reported that, when developing your business strategy, firstly it is necessary to analyze the changes on the environment, in other words, study the main environmental factors affecting the company and its likely development, as well as new factors that may exert influence in the future.

And, posteriorly, it is necessary to analyze the resources and competences, that is, analyze the systematic efforts to expand the knowledge of the resources and the competence of the company in order to optimize the existing supplies by means of an effective and selective allocation.

It was also noted that 33% of the companies reported having a formal, explicit and disseminated business strategy, which means that these companies strategically plan, organize, direct and coordinate the whole process.

According to the answers, it was observed that the managers of small and medium companies establish a balance of the demands of internal and external environments, as well as the integration of all sectors of the organization. Intending, thereafter, optimize the allocation of resources and ensure the achievements of goals and objectives.

The companies that stated that the business strategy comprises only one non-formalized idea which is shared by few individuals in key positions account for 17% of the sample, as shown in Figure 2. It was observed that these companies aim to simplify and process efficiency.

Finally, it was verified that 3% of companies reported that their business strategies are in process of elaboration, that is, they are creating a focus on business decisions with emphasis on the importance of efficiency and effectiveness in their processes.

The Figure 3 presents the results of technological strategy, that is, it is presented whether small and medium companies focused their efforts in the identification of the structural factors that affect the innovation performance.

Analyzing Figure 3, it was noted that 52% of the studied companies reported that the technological strategy

comprise only one idea which not formalized and is share with few individuals in key positions.

The interviewees argue that, in order to improve the technological strategy, it is necessary to create a technological intelligence, which would help in the process of identification and anticipation change, thus ensuring that the plans would not become quickly obsolete.

It was also observed that there is no consensus on a precise definition of what constitutes a technological strategy or even on its extension. It was found that 39% of companies do not express an opinion about what technological strategy is.

Due to the rapid technological change and the increasing concern about generating and managing these changes, aiming at generating competitive advantage, it was noted that 6% of the companies reported that their technological strategy is in process of elaboration.

Finally, it was observed that 3% of companies reported having an informal technological strategy, that is, they have an explicit strategy, but it is restricted to some levels of management.

It was perceived that the greatest difficulty in implementing the technological strategy is the doubt about the subject. Many entrepreneurs said that they do not possess knowledge about the topic.

However, others interviewees raised the following issues, which form the basis of this strategy: how to choose the most appropriate technological alternative? What are the technological resources available? What will be the skills required in the future?

With this analysis, we concluded that an integration between business strategy and technological strategy is necessary in order to establish a language which is common for both areas.

FINAL CONSIDERATIONS

Industrialized countries have difficulty in maintaining its economic leadership in the process of permanent threat of global technological dynamism. It requires, by their companies, a continued investment in R&D aiming at innovations that allow maintaining competitiveness (Coutinho, 2004).

The less industrialized countries experience a shortage of financial resources and macroeconomic instability that inhibits general investment, especially in technology.

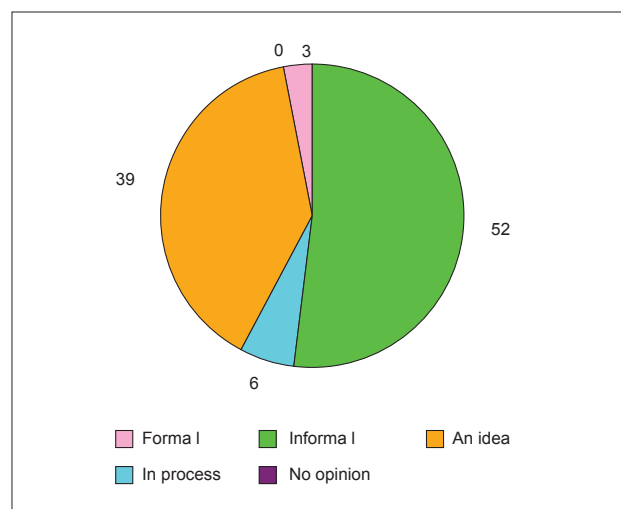


Figure 3: Technological strategy.

This study aimed to establish a concept of Technological Strategy, presented a proposal of assessment of the technological and strategic positioning of small and medium technology-based companies inserted in the aeronautical sector of Caçapava, São José dos Campos and Taubaté. In order to do that, a specific questionnaire on technological posture was employed, thus identifying the demands required to ensure the development of competitiveness of small and medium companies.

The authors found that these companies do not have enterprise scale that allow incurring voluminous spending on R&D. Most of them position as proactive and reactive followers and work significantly in incremental and process R&D, thus acting not much with application R&D.

The results indicate that small and medium technology-based companies of the aeronautical sector located in Caçapava, São José dos Campos and Taubaté did not have a formalized and disseminated technological strategy throughout their history.

Therefore, it can be concluded that it is necessary that companies, especially small and medium-sized, adopt a technological innovation strategy integrated with the company's overall strategy, thus helping them keeping their competitiveness within their specificities not only in the national market but also internationally.

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