

# FAPESP's Innovative Small Business Program (PIPE) as development inducer of technology-based enterprises

## *O Programa Inovativo da Pequena Empresa (PIPE) da FAPESP como indutor do desenvolvimento de micro e pequenas empresas de base tecnológica*

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**Abstract:** This text examines the relevance of the development support for small business enterprises with a technological basis in the form of a “package” of strategic resources and capabilities, embedded in a short space of time through the FAPESP’s Innovative Small Business Program (PIPE). The study approach was the resource-based view (RBV). The qualitative methodology was adopted with the application of content analysis. The data were obtained during interviews based on a structured roadmap with open-ended questions conducted with the partners/managers of ten small technology-based business enterprises divided into two groups, one consisting of companies benefited by the PIPE and the other containing those that used their own resources. The intention was to compare their evolution. The study results indicated that the PIPE provided decisive support encouraging the development of the businesses benefiting from it. One of the relevant gains was the faster availability of additional resources as a result of the productive combination of the enterprises’ pre-existing resources and capabilities with those obtained through the program. An important finding was that small business enterprises with a technological basis have grown in the market, regardless of the help received, they featured differentiated technology, partners/managers with a clear view of their markets, and the aim of creating value for their products and services. This research limitations included the selection of small business enterprises with very different products to compare successes.

**Keywords:** Resource-based view; Dynamic capabilities; Strategic resources; PIPE/FAPESP; Small business.

**Resumo:** Este texto analisa a relevância do apoio ao desenvolvimento de micro e pequenas empresas de base tecnológica na forma de um “pacote” de recursos e capacidades estratégicos incorporados em um curto espaço de tempo, por meio do programa PIPE da FAPESP. A abordagem adotada foi a da Visão Baseada em Recursos (VBR) dado o foco do estudo. Adotou-se a metodologia qualitativa com a aplicação da análise de conteúdo. Os dados foram levantados com base em entrevistas com um roteiro estruturado com perguntas abertas junto aos sócios/gestores de 10 empresas de base tecnológica divididas em dois grupos, um deles constituído por empresas beneficiadas pelo PIPE e o outro por aquelas que utilizaram recursos próprios. A intenção foi comparar a sua evolução. Os resultados do estudo indicaram que o apoio do PIPE foi decisivo para favorecer o desenvolvimento das empresas beneficiadas por ele. Um dos ganhos relevantes foi o encurtamento do tempo do caminho percorrido para a disponibilização dos recursos complementares, como decorrência da combinação produtiva dos recursos e capacidades pré-existentes nas empresas com aqueles obtidos por meio do programa. Uma constatação importante foi que, para as empresas terem crescido no mercado de base tecnológica, independentemente da ajuda do PIPE, foi decisivo possuírem inicialmente uma tecnologia diferenciada, os sócios/gestores terem uma visão clara dos seus mercados e voltados à criação de valor para os seus produtos e serviços. A limitação da pesquisa está na seleção de pequenas empresas de base tecnológica com produtos muito distintos dificultando comparações sobre sucessos.

**Palavras-chave:** Visão baseada em recursos; Capacidades dinâmicas; Recursos; PIPE/FAPESP; Microempresas.

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## 1 Introduction

Small technology-based enterprises are industrial organizations with fewer than 100 employees or service enterprises with fewer than 50 employees that work with the design, development, production and marketing of products or processes, characterized by the systematic application of technical and scientific knowledge (Machado et al., 2001).

Arising from the use of technology as a major portion of their business and due to the fact that their development demands a volume of financial and technological resources that is beyond their ability, it is common for these enterprises to use outside sources to complete the feature set required for their expansion. Given their specific internal conditions, some are able to support their management and technological development and their financial business with government agencies, while others have to resort to their own resources and other sources.

In view of this circumstance, it is natural to ask how relevant it can be to the development of small technology-based enterprises to obtain this support in the form of a “package”; specifically, is this differentiated condition regarding the acquisition of initial resources and capabilities in a short time span really effective?

To obtain the answer to that question, it was considered relevant to analyze enterprises that benefited from the Innovative Small Business Program (PIPE), funded by the Foundation for Research Support of the State of São Paulo (FAPESP), which offers this kind of support to small enterprises with a technological basis, compared with others that did not, to identify possible differences in their development.

The PIPE, based in the state of São Paulo in Brazil, is intended to support the development of small enterprises through the use of scientific research focused on technological innovation. This program provides financial resources for purchasing equipment and subcontracting to third parties as well as support for a research associate for projects (FAPESP, 2014). Further details are presented in the next section.

To find the answers to the questions raised above, the authors opted for the approach of the resource-based view (RBV), which argues that a company gains a sustainable competitive advantage when its products or services can create greater economic value for the client based on the resources and capabilities involved in its production, providing a financial return above that obtained by its competitors (Wernerfelt, 1984; Barney, 1991; Grant, 1991; Bowman & Ambrosini, 2000; Peteraf & Barney, 2003).

To conduct research to answer the question originally posed, the aim was to understand how the features and capabilities obtained and developed by means of the PIPE were effective in the development of this type of enterprise compared with enterprises that did not

have access to this program but that also managed to survive and grow, focusing on the identification of the support contributed by the program and the strategies for development.

A synthesis of the rules of the PIPE program, the theoretical framework with the fundamentals of the RBV concepts, the methodological procedures with the justifications for undertaking an exploratory study and the qualitative method are presented, followed by the analyses based on the information that was verified in the interviews with the entrepreneurs. The paper concludes with the final considerations that contain the answer to the research question and the learning obtained.

## 2 Innovative Small Business Program – FAPESP’s PIPE

The PIPE program was created in 1997 to support the implementation of scientific research and/or technology applied in small business enterprises based in the state of São Paulo in Brazil. The projects selected to benefit from the program are developed by researchers employed by a small business or its partners.

The objectives of the PIPE are: a) to support science and technology research as a tool to promote technological innovation, promote business development and increase the competitiveness of small enterprises; b) to increase the contribution of research to social and economic development; c) to induce increased private investment in technological research; d) to enable enterprises to link researchers in the academic environment to research projects aimed at technological innovation; e) and to contribute to the formation and development of technological development centers in enterprises and to the employment of researchers in the business labor market (FAPESP, 2014).

This program consists of three phases, the first of which is intended to demonstrate the technical and commercial feasibility of the research proposal and has the expected duration of nine months.

The second phase is intended to implement the research proposal itself, lasting for up to twenty-four months. To receive funding during this period, the company must submit a business plan for the marketing of new products.

The third phase is dedicated to the development and manufacturing of new commercial products based on the previous phases. Certification and other types of accreditation are also sought here.

The program comprises four basic guidelines to induce the process of innovation and create the necessary conditions for the development of skills. a) Research should be conducted with the aid of a researcher as a partner or employee. The presence of this researcher seeks to bring two benefits: the

introduction to the university and the knowledge and experience that are contributed to the company from the beginning; b) The presentation of the project for approval involves a series of questions that includes companies' own preliminary study of the market into which they intend to introduce the product or service innovation; c) In the second phase of development, third parties are hired up to 50% of the value of the project to enable the aggregation of a range of complementary skills; d) The financial support is intended to provide training and continuity of the team through the financing of research scholarships and technical training. Consumption material and third-party services (consulting, testing, component development, etc.) are also financed.

This takes into account the profile of the requesting entrepreneur, since it is an attribute that is considered to be important for the success of an innovation project, given the need to integrate and combine the company's resources and competences.

### 3 Theoretical references

This section is structured in accordance with the key concepts inherent in the objective to maintain consistency between the development of the data collection instruments, the analysis and the final considerations.

#### 3.1 Strategic resources

Barney (1991, 2011) argues that the capabilities of an organization include all the tangible and intangible assets, capabilities, organizational processes, attributes of the business, information and knowledge, among others, that allow the company to devise and implement strategies that enhance its efficiency and effectiveness. Such resources are strategic for the creation of economic value superior to that of its competitors by allowing the provision of differentiated products in the market.

According to Barney (2011), the creation of higher economic value requires the resources used in the generation of the product to have four attributes: a) add value to the product over that of competitors; b) are rare among current and potential competitors; c) are difficult to imitate and cannot be replaced by other, strategically equivalent, resources; and d) are held by an internal organization able to exploit the potential offered by these features, including the formal structure, the management and control systems and the compensation policies.

Among the relevant strategic resources, Helfat & Lieberman (2002) highlight the entrepreneur's previous experience and knowledge of suppliers and customers that he can use for making choices in the market. The greater the similarity between the resources of the entrepreneur and those required for

entering a new market, the greater the possibility of success. Even so, the company needs to find new resources to compensate for its shortcomings that arise in the face of new opportunities but that may not be available in the resource market or be created as quickly as necessary.

In addition to the financial capital and management support that are provided by the PIPE, the role of a research associate is emphasized. According to Hatch & Dyer (2004), human capital is a feature that enables a competitive advantage, because it is difficult to fake and starts with the human resources that are internal to the company in the form of the knowledge and skills inherent in people. The stock of human capital in a company comes from the selection, development and use of this feature to give it a unique ability to provide goods and services that are superior to those of competitors.

According to Tidd et al. (2008), the major challenges faced by micro and small technology-based enterprises involve the scarcity of financial resources, weaknesses in technological skills and little ability to develop and operate management systems as well as to take the long-term risks inherent in innovation and the consequent value creation.

As strategic resources are difficult to use alone or independently, Adegbesan (2009) presents the concept of complementarity from the perspective of combining resources, whereby those obtained externally are combined with those available within the company itself. This concept is particularly relevant in the case of small technology-based enterprises that use the market in search of complements for their resources. Thus, if it is important for them to acquire the missing resources, the productive combination between the existing resources and the new ones that they have gained is fundamental.

In the type of support offered by the PIPE, there is the possibility of improving the factors necessary to achieve a differentiated performance of the company, as pointed out by Zott (2003): a) the time of delivery of the resources; b) the cost of this delivery associated with time; and c) the dependence of the path associated with accumulated learning on the delivery of resources that feed this performance differential. Thus, this type of external support would accelerate the acquisition of resources, reduce their costs and provide external knowledge that would be reflected in the acceleration of learning and the reduction of time and could produce a competitive advantage.

For Teece (2009), from an initial and complementary contribution, the consolidation and the subsequent growth of the company lead to the increase of its base of resources and assets. Success leads to the accumulation of more resources and specific assets, as well as internal rules and procedures, and the company expands through a path-dependent process.

The key to sustainable, profitable growth is the ability to reconfigure assets and organizational structures as markets and technologies change. Reconfiguration is necessary to maintain adaptation and to try to escape from dependence on unfavorable paths (Teece, 2009).

### 3.2 Dynamic capabilities

The dynamic capabilities approach is seen as a potential integrator of the vision of resources and competences in the understanding of the creation as well as the sustention of enterprises' competitive advantage (Lin & Wu, 2014; Meirelles & Camargo, 2014).

The study of dynamic capabilities is a flourishing branch of management research activities (Meirelles & Camargo, 2014). According to the recent bibliometric surveys carried out by Vogel & Güttel (2013), this literature has experienced significant growth in the last five years, in areas such as strategic management, entrepreneurship, marketing, human resources, operations and information systems.

The concept of dynamic capabilities originated from RBV authors (Wernerfelt, 1984; Barney, 1991, 2011), who claim that they are made up of a subset of the resources that enable a company to utilize its strategic resources productively.

Complementing this understanding, Newbert (2007) argues that resources, both tangible and intangible, have no value for the company in isolation. On the contrary, their latent value can only become available to the company through their idiosyncratic dynamic capabilities.

Meirelles & Camargo (2014) mention the importance of incorporating the role of environmental dynamism into determining a competitive advantage and, above all, the way in which enterprises react to this dynamism over time. This occurs through routines, processes or even other capabilities (Pavlou & El Sawy, 2011), through which the organization achieves new configurations of resources and capabilities (Helfat & Winter, 2011).

Criticizing the fact that the RBV's concept of capabilities did not initially consider its development in rapidly changing environments, Teece et al. (1997, p. 516) define dynamic capabilities as

[...] the company's ability to integrate, build and reconfigure internal and external capabilities to meet the demands of rapidly changing environments.

According to the authors, it is a peculiar process formed by the specific assets and the path of evolution that the company has adopted or inherited and that leads to the development of dynamic capabilities. These capabilities, external and internal, are company-specific and allow the company to overcome threats in the environment.

Because the enterprises on which the study focuses deal with technologies in rapidly changing environments, the concept of dynamic capabilities of Helfat & Peteraf (2003, 2009) is defined as those that purposefully create, expand and modify their strategic resources. Although the authors are identified with the RBV, their concept has evolved to consider an environment of rapid changes in the development of capabilities.

As regards the full building of dynamic capabilities, Helfat & Lieberman (2002) argue that this process is dependent on the path taken based on the initial choice for the success of the new alternatives and on the choices made within the set of alternatives.

Helfat & Peteraf (2003) understand that dynamic capabilities originate from the initial configuration of the human capital, social capital and knowledge of the people who form the groups in the organization and are consolidated through an iterative technical process or the search for alternatives and the reflection of the groups on these attempts.

Helfat et al. (2007) consider that the creation, expansion and modification of a company's resource base are dependent on how its managers approach these resources and capabilities and how they convert opportunities into real actions. For these authors training, association or external support, product development, innovation and other actions are factors that are controlled by the managers of the enterprise, and, depending on their managerial posture and the adopted strategy, they will have a greater or lesser effect on the formation of dynamic capabilities.

On the other hand, Danneels (2002) affirms that product or market innovation previously undertaken by the company or incorporated by its main managers generates dependence on the previous path due to its effect on the company's competences, which in turn influence the new products. This author introduces the concept of second-order competence, which is the competence for exploratory learning, defined as the ability to identify, evaluate and incorporate new technical or consumer-related skills. In short, adding new skills to the company's repertoire is important for its continued prosperity in a changing environment and for the establishment of its core competencies.

Seeking an external connection to capabilities, Danneels (2007) argues that market-related resources constitute "consumer competence" – a company's ability to serve a particular market. Such competence would include knowledge of consumer needs, preferences, purchasing procedures, distribution and access to sales by customers, the reputation of the company and its brands and communication channels for the exchange of information between the company and its consumers during the development and commercialization of the



product. Besides this, the author presents the concept of “marketing competence,” which is the ability of the company to build resources related to new markets. This includes skills in such areas as surveying the potential of new markets, building relationships with these markets, establishing new distribution and sales channels, improving the brand and company reputation for new markets, researching competitors and new consumers and developing advertising campaigns and promotion and pricing strategies.

From a process view, Teece et al. (1997) and Teece (2009) argue that dynamic capabilities are the basis for feeling the market (sense), evaluating the characteristics (seize) and reorganizing the resource base to face the threats (reconfiguration). The organizational and managerial processes that support these capabilities are coordination/integration, learning and reconfiguration, which together can be considered as processes of asset *orchestration* (Teece, 2009).

For this reason Teece (2009), relating the dynamic capabilities to the competitive advantage of the company, argues that this is generated not by the position in the market but by the integration of resources that is achieved by its dynamic capabilities, which are capable of creating a differential in the market.

In the case of the resources provided by the PIPE, these can bring three types of aid to the formation of dynamic capabilities: a) the subcontracting of third parties who already possess the additional capabilities necessary for the company; b) the contribution of knowledge by the associated researcher, necessarily someone with knowledge in the area of activity of the company, contributing his or her already-developed capabilities; and c) alliances with research institutions that have other capabilities demanded by the company and that can incorporate them, completing their needs, promoted by the researcher.

### 3.3 Developing resources and capabilities

According to Newbert (2007), given the intangibility of dynamic capabilities and the difficulty of their measurement, in addition to being tacit, socially complex or causally ambiguous (difficult to identify objectively), it is important to recognize the strategies adopted by enterprises that lead to the creation and development of these capabilities.

Newbert et al. (2005) argue that management-based enterprises at their foundation adopt demand-tracking strategies, while companies that were based on technology competencies at their source emphasize strategies in which technology drives business.

The policy and human resource strategy, according to Barney & Clark (2007), should value people and their

performance in the process of gaining a competitive advantage to achieve economic consequences. This can occur based on the formation of the employees' skills and their commitment to the objectives of the company and the value created. In this sense it is necessary to determine which practices and relationships define competition, which of them must be innovated to provide a temporary advantage and which provide a unique condition for the company (culture, history, management systems, etc.)

According to Teece (2009), a company's internal strategies that seek a competitive advantage are based on the identification and adjustment of the technologies to the market opportunities, the appropriate selection of the technologies against the attributes of the products, appropriate projects of the business models, the commitment of financial resources to investment opportunities and the training and development of human resources. The growth of profitability allows the company to increase its level of resources and assets, and success will cause it to evolve in a way that is dependent on this path.

According to Hamilton & Singh (1992), there is a close link between business strategies and dynamic capabilities. The strategy provides the paths and gives the support and resources needed to develop dynamic capabilities. These in turn determine the future strategic choices insofar as they depend on the path taken for their development and for this reason determine the next steps of the strategic decisions. This process creates the dependency of the path and the ability to preserve the knowledge of the company and make it difficult to imitate.

## 4 Methodological procedures

Considering the objective of the study, exploratory research of a descriptive nature (Collis & Hussey, 2005) was carried out, aiming to identify the behavior of the phenomenon and obtain information based on the opinion derived from the experience of owners of small technology-based enterprises that had participated in it.

### 4.1 Study environment

Ten small enterprises were selected, which would have been able to create value for their clients in the search for a competitive advantage and which performed different activities and did not compete with each other. The survey was conducted between 2011 and 2012. The enterprises were divided into two groups for comparison purposes in accordance with the following criteria.

First group:

- a) Enterprises that received PIPE resources between 2000 and 2005 and that remained active and in development for a minimum period of five years after full utilization of the support (the program lasts for three years). If there had been a very long time between the actions of the program and the research, the current reality of the company could include other actions that could de-characterize the effect of the resources contributed by the program;
- b) Enterprises that had participated in incubators in which they would have acquired the basic administrative procedures to conduct the day-to-day running of their business. The reason for this choice was to give uniform treatment to strategic issues so that any differences would not be attributed to deficiencies in basic management processes. This is because incubators maintain support that is very similar to the PIPE.

Second group:

- a) Enterprises that did not receive funds from the program but that had introduced their products to the market at the same time as those benefiting from the PIPE, for the same reason as mentioned above;
- b) Continued growth of the sales of their products or services in the last five years as an indicator of positive developments in their business, based on information obtained from the enterprises themselves.

Because the respondents did not authorize the disclosure of company names, they were identified by capital letters followed by their most relevant business, as shown in Chart 1.

Among the selected enterprises, seven received support from the PIPE and three did not receive any help from this program or any other similar external support; that is, their development was based on their own resources obtained by other means. The comparison of the evolution of these enterprises was important for the analysis of the relevance of the PIPE’s support, given the different processes for obtaining external resources and their subsequent development.

4.2 Collection and processing of data

As the study was qualitative, the content analysis technique based on Flick (2004) and Bardin (2009) was used. The data collection was carried out through interviews with the main partners/managers of the enterprises, who had considerable experience in the business; in total 10 people were interviewed.

The interviews were conducted with the support of a structured script containing open questions linked to the study objective. Accordingly, a matrix was used in which the specific objectives of the study were first placed in the columns followed by the key concepts of the theoretical references. The third column consisted of the questions of the script, elaborated by means of horizontal readings and syntheses that ended up making a connection with the specific objectives. This method sought to guarantee the basic consistency of the study.

The interviews had an average duration of 60 minutes and were all recorded with the permission of the interviewees. They were then transcribed and subsequently validated by the interviewees.

To facilitate the operationalization of the data, an Excel spreadsheet was used. The transcripts of the interviews were treated in such a way as to obtain a categorization that allowed the productive analysis of the interviewees’ testimonies. The categorization process comprised the following phases of analysis, as recommended by Bardin (2009), but with adaptations in view of having adopted the pre-coding established by the questions and not having used any quantitative treatment:

Chart 1. Business of the study enterprises.

Empresa	Type of business
A	Development of software and games for management and training.
B	Systems of remote monitoring of water and electricity.
C	Technology for laser applications in industry.
D	Use of cellular technologies in monitoring systems.
E	Production of medical devices for artificial respiration in ICUs (intensive care units).
F	Building automation and business management software.
G	Integrated management of benefits and health systems for companies.
H	Integrated training with courses in distance education, videos and audio for cooperatives.
I	Implementation and management of distance education systems for universities.
J	Tire vulcanization technology.

1<sup>a</sup> phase: Elaboration of the matrix of questions and answers

To achieve this, the questions were placed in the first column of an Excel spreadsheet and the essential passages in each interviewee’s speeches were identified, which were the semantic units, that is, the keywords, expressions and phrases that adhered more closely to the essence of each question. Then adjustments were made to connect the semantic units to the most pertinent questions, because, in all interviews with an open script, answers are not always given exactly in the order in which the questions are asked.

2<sup>a</sup> phase: Elaboration of the themes

In the sequence the semantic units corresponding to each interviewee were read in the horizontal direction of the worksheet. This procedure had the purpose of reducing and synthesizing the semantic units in the search for a unique answer to each question, the product of which gave rise to a new column: themes.

Then a reduction of the themes was obtained by reading this column vertically.

3<sup>a</sup> phase: Categorization

The categories were elaborated from the new reductions and consolidations of the themes resulting from the previous phase, seeking to be consistent with the objective of the study, which constituted its guiding element. The intention was to achieve a minimal expression that represented the greatest meaning for the material that had been consolidated and reduced (Flick, 2004). Chart 2 shows the categories elaborated as a result of this data-processing procedure.

5 Analysis of the results

This section is structured according to the categories in Chart 2, and the analyses are carried out based on the statements in correspondence with the concepts presented in the theoretical framework.

Because the vast majority of the respondents did not allow the disclosure of their enterprise’s name, the transcripts of the most relevant sections of the

testimonies are identified in capital letters, as shown in Chart 1.

5.1 Resources obtained from the PIPE

The choice of the PIPE allowed the possibility of supplying practically everything that was needed to start the business in the same place. The entrepreneurs interviewed realized that they would have to evaluate and invest in the human resources that would be needed for the later stages that their enterprise would face (Hatch & Dyer, 2004).

The surveys of the training needs to act in the markets and the measures taken as a result of these evaluations were thus reported by the interviewees:

*They are difficult professionals to find themselves ready in the market. It was necessary to train most people [...]. (A)*

*The learning program is continuous and with a high impact on the management of the company. [...] we live management cycles according to the new knowledge developed. (G)*

*Trainings still happen on their own. We have people today if we have to develop a new product [...]. (H)*

The enterprises did not have exclusive scarce resources, such as patents, licenses and raw materials, under unique supply conditions, which gave them a previously established differentiated condition for market disputes.

In the absence of ex ante ownership of differentiated conditions for exclusive resources, the enterprises had to be founded on the knowledge of the partners and other capital resources or assets that they already owned. The knowledge resources held by entrepreneurs were from their own development and previous experiences, which enabled the condition of know-how (Helfat & Lieberman, 2002). However, other resources were effectively needed to complete those that the enterprises already possessed.

The starting conditions had a great effect on the capabilities that were developed along the paths that the enterprises followed later and defined

Chart 2. Categories of analysis.

Focus	Categories
a) Resources and capabilities contributed by the PIPE and those developed as a consequence.	Resources obtained from PIPE.
	Knowledge of the researcher.
	Expansion of the resource base.
	Capabilities to create new products and technologies
b) Strategies for the development of integrated resources and capabilities.	Management and technological strategies.
	Development of people internally.

their subsequent behavior towards the search for a competitive advantage (Barney & Clark, 2007).

The experiences of the partners of the enterprises before their founding were of different natures: three in the area of technology, only one of them in management and the others associating experiences in technology with management.

The enterprises needed complementary assets and technologies to support the commercialization of the products/services with their basic technology. Such assets included manufacturing, distribution, sales and services that existed internally or otherwise were available through mergers, acquisitions or contracts.

Once the needs had arisen, the missing resources were identified: financial for six enterprises, technological for one and both resources for the other three. It should be clarified that the missing technological resource was necessary to materialize production with the technology already possessed, which would have to generate a product/service for the market to be served, and not the basic technology already dominated by the entrepreneurs.

The enterprises searched for additional resources to complete the internal processes until the launch of their products (Adegbesan, 2009).

The missing resources, sources and ways in which they were sought can be illustrated by the following statements:

*We get resources in PIPE [...]. FAPESP helped the dream too much [...]. (C)*

*Our problem at the time was the lack of financial resources. There, we obtained funding from Fapesp (PIPE) [...]. (D)*

*We needed resources for the purchase of equipment, the purchase of equipment, the stock market [...]. (E)*

*We sent a project to FAPESP that included the machine and the software for the control of the process [...]. (J)*

Of the enterprises that did not use the PIPE, two were obliged to admit members who would bring what they lacked and another one sought financial resources in another institution, the support of which is similar to that of the FAPESP:

*It was necessary to add a partner. We did not have enough competence, nor the capital to hire someone to do what was needed [...]. (G)*

*[...] we are looking for a partner to take care of the market share. (I)*

The funds obtained from the PIPE were used with the purposes and exerted the impacts in the enterprises as shown in the following statements:

*[...] the great impact was to have put on the market a new product that is being manufactured to date and accounts for about 20% of the billing. (A)*

*[...] were bought with the money from PIPE laboratory equipment and contracted engineering services to perform some tasks that we would not know how to do. (B)*

*[...] money also served to develop the prototypes [...]. (J)*

*[...] the company was capitalized with this first entry of FAPESP money. It also got an engineer with a scholarship [...]. (C)*

*PIPE has helped a lot. In addition to adding human values, people with different capabilities to develop the products, we also had the support for the purchase of equipment. (H)*

The support was concentrated on the purchase of equipment and the hiring of personnel, which were decisive in assembling the resource bundles necessary to face the markets that they proposed.

## 5.2 Knowledge of the PIPE researcher

This category of analysis concerns the presence of the researcher and his or her contribution to the enterprises.

The researcher was relevant in enabling the enterprises to gain complementary critical assets, intellectual property and scarce talent. He or she provided support to develop the company's ability to assemble, disassemble and rearrange elements of the value chain and expand the range of technology options that the company could choose (Teece, 2009).

The performance, knowledge and relations contributed by the researcher can be illustrated by the reports of the interviewees:

*The researcher was a doctor in the area of entrepreneurship. [...] we did not know anything. We learned a lot about it. (A)*

*[...] he brought all the technology that was the foundation of the company at its inception. All other products were developed from this initial base [...]. Everything he brought is incorporated into the company. (J)*

*The researcher has brought much of the technology we have. He had the technology and previous experience as a manager in this kind of business. (C)*

*[...] the researcher brought everything for the company to start: technology and market knowledge [...]. He also had managerial experience. (H)*

As a result the presence and expansion of the dynamic capabilities of the enterprises through the researcher's performance became apparent.

Enterprises that did not receive support from the PIPE or another similar program needed to seek



knowledge or financial resources from partners. In these cases there was no previous capitalization for the purchase of machines with these resources, essentially transferring technological and/or market knowledge. In any case additional capabilities were provided that gave final support to market strategies (Adegbesan, 2009).

### 5.3 Expansion of the resource base

This category revealed that, after the cessation of the PIPE support, there was a need to expand the resource base to guarantee the positions won in the market.

One characteristic of dynamic capabilities is the ability of a company to feel, evaluate and reconfigure its markets as they evolve (Teece, 2009). This holds true mainly in technology-based markets that present innovations quickly. In this sense the interviewees were asked whether, after the company's entry into the market, there was a need for managerial, product, process, market and other technological changes. The answers were affirmative, revealing that the competition for markets became more fierce in the new spaces occupied, causing changes in technology, products, market strategies and management, as the statements below show:

*Management changes were very small. But we have changed the technology a lot. We have also changed our products a lot and we are researching what the next technology will be. (F)*

*[...] we had four major cycles of change and innovation. In all there were managerial, strategic and product changes. All were identified with the customers and the answers given were on the products offered as they were suggested. (G)*

*At first we had the idea of making the machine. Then we saw that the important thing was software, and the knowledge gained from it turned out to be a new product. There was a need to adapt to offer consulting services, to sell and assist the use of software [...]. (J)*

These movements were relevant and necessary and constituted the search for the complementary assets that expanded and consolidated the operations of the enterprises, assisting in the generation of value for the clients, as these assets created dependence on the path that made it difficult for competitors to imitate (Danneels, 2007; Teece, 2009).

### 5.4 Capabilities to create new products and technologies

This category involved two basic issues, core competence (Newbert, 2007) and the presence of dynamic second-order capabilities, as advocated by Danneels (2007).

Regarding the basic competence, the interviewees gave indications of their existence in the following way:

*[...] we make this adaptation for every new challenge we receive. There's always something different coming on [...]. (C)*

*We have competence and this can be applied to a wide variety of products [...]. We have a capability to meet, to turn around to create what the customer needs. (D)*

*We spent five years researching to make a new product. But it's a family of products with slightly different applications. (E)*

*[...] we are using our competence to develop the new products that we need to have when the competition reaches us. (G)*

However, if this core competence is to be reflected in actions outside the company, it must incorporate the skills and knowledge related to the market that form the "consumer competence" and the "marketing competence" (Danneels, 2007) and are relevant to performance in the market, which should have occurred minimally according to the following statements:

*Today we continue in this dispute to conquer the market [...]. In the foreign market we are looking for a little more. (A)*

*[...] we have a customer service that is very good and the customers like it. We understand well the needs of our customers. The new products and solutions were made on request or under pressure from customers. (C)*

*Today we know everything about the market, the competitors, the products, the customers [...]. (D)*

*Given our previous experience we know this market quite well. (J)*

### 5.5 Management and technology strategies

Most of the change and innovation processes were adopted to meet customer requests and make technology changes, that is, when changes occurred in the customer-product relationship.

The positioning to serve the markets allowed the companies to obtain relevant knowledge about the generation of value and the capability to react to the demands (Newbert et al., 2005). With structures of a few hierarchical levels, the enterprises were able to offer a fast, differentiated and unique service to each client or client segment, as shown in the following statements:

*The changes have been made to meet what the market asks us. Our incentive is to always attend to the market and continue ahead. (A)*

*We seek to hire entrepreneurial people who know a technology company. The innovations in our products are always made according to the market and according to the evolution of the technology. (B)*

In general the decisions were taken jointly by the partners and executives, which stimulated the creation of a team spirit, allowing consensus in the choices of the directions taken for the company. This created path dependence that over time consolidated a set of procedures and routines that made its products and processes difficult to imitate, helping to generate value for customers (Hamilton & Singh, 1992).

In the opinion of the interviewees, there was still much to achieve in relation to the markets in which they operate to defend their enterprise's venture in different ways.

The most relevant strategic option was to make investments in technological upgrading as the company's first priority (Teece, 2009). Of the ten interviewees, four made technology-based decisions, four others used both managerial experience and technology choice and only two based their decisions solely on their managerial experience and their partners.

*Decisions are always taken with a view to the market, the new products and the company's capacity to expand. (B)*

*The investments we are making are always for the upgrade of technology or for new applications that customers are asking for. Sometimes we make some expenses to expand the place or to improve working conditions. (C)*

The enterprises that were originally based on technological capabilities emphasized strategies in which technology pushed the business. This choice determined the resources that they had at their disposal and the tendency to seek the support of the PIPE. The enterprises that did so achieved a good result when associating the technology with the demand in a unique way; that is, at the same time that they evolved with the technology, they attended to the markets in this process (Newbert et al., 2005).

Having technological capability enabled these enterprises to favor the internal development of human resources, because it is more difficult to replicate a narrow-domain technology. Eventual competitors would have to tread a path that would require continuous learning while requiring the same technology to generate equivalent technology to that obtained by the study enterprises (Barney & Clark, 2007; Barney, 2011). Meeting the demand on the technological side could make the actions of enterprises imitable, easily eliminating the possible competitive advantage achieved (Danneels, 2002).

## 5.6 Development of people inside

To elaborate this category, the strategies of the enterprises regarding their human resources were identified, focusing on the value of people, their available skills, the necessary skills training and leadership in the vision and motivation of the employees.

The practices favored home-based training, and in some cases the enterprises possessed a unique technology that reinforced training within the company's values, not only in relation to technology but also in relation to its various applications, the relationship with customers and the incessant search for updating. The economic consequences of human resource practices aimed at the training of employees' abilities were also considered in relation to their commitment to the company's objectives as well as to the evaluation of the value created (Barney & Clark, 2007).

This knowledge was particularly important for building new capabilities and consolidating existing dynamic capabilities. This caused their differences to remain over time and possibly generated higher value because they are difficult to imitate.

The training processes adopted reinforced the consolidation of current knowledge and greater openness to clients, with new services and applications but with the same technological bases with which they had conquered their current position.

The integration of factors such as training, the search for association or external support, product development, innovation and others, depending on the managerial posture and strategy adopted, apparently influenced the formation of dynamic capabilities.

In summary the strategies adopted were a process of development, expansion and consolidation of dynamic capabilities from the initial conditions of the capabilities of the enterprises that were brought by the partners, and the complementation by other means of the initial technological conditions made this option a safe direction.

## 6 Final considerations

To return to the question posed at the beginning of this article, namely how much the differentiated condition in obtaining initial resources and capabilities from the PIPE incorporated in a short time could be relevant to the development of small technology-based enterprises, the answer is positive, at least for the enterprises that participated in the study.

Taking into account the fact that all of them were considered to be successful in their business, it was found that those that used the PIPE managed to grow in a more organic and regular way, having developed their resources and capabilities more

effectively and productively, including the reduction of the development time in this process.

The enterprises had an important initial resource, the founder, with his or her previous experiences and possession of resources and technological capabilities as well as unique information about the markets in which he or she intended to act. This was decisive for those enterprises that obtained the support of the FAPESP, which requires a minimum of conditions to approve projects and forced the entrepreneurs to reflect on and plan their actions, focusing on the results that would be obtained by the supporters.

The resources and capabilities deployed were important in the execution of the business strategies due to having shortened the time spent in relation to the enterprises of the study that did not count on this support. Financial and technological resources were leveraged and additional technical personnel were hired, with emphasis on the researcher, who made a decisive contribution to the technological development and expansion and the consolidation of the dynamic capabilities of these enterprises.

The PIPE provided financial resources with a broad spectrum of application. With these, machines and equipment, specialized labor and third-party services could be acquired, as if they were a single package. The enterprises were thus able to accelerate their market entry process, being practically ready to compete with high chances of success by having a full range of resources and capabilities.

The other enterprises that did not use the PIPE faced a more gradual and irregular process of resource complementation through consultancies and other modalities, which extended even after entering the markets, requiring much greater effort and costs to conquer their space. Although these enterprises also followed different routes, they all sought some form of external support, with the most adopted solution being to incorporate new partners with the complementary knowledge, financial resources and skills that they lacked. In these cases the evolution was more discreet and based on the reinvestment of their own resources. The lack of initial support conditioned them along the way, prioritizing self-sufficiency in relation to financial resources.

The analysis of the strategies of the enterprises that benefited from the PIPE for the development of resources and capabilities showed an emphasis on human resources to update the technology and to improve the culture, focusing on the search for a competitive advantage. This enabled them to maintain a steady pace at least until the time of the research.

In summary the group of enterprises that participated in the research managed to grow in a technology-based market for two reasons. The first was having differentiated technology initially, a clear vision of the possible markets to be satisfied with what they had and entrepreneurs focused on creating value for the markets. The second was the productive combination of their pre-existing resources and capabilities with those brought in from outside, generating a synergy that resulted in the final suitability of the products for the markets.

However, it is necessary to indicate the most significant differences between the two groups of study enterprises: a) those that used the PIPE had lower costs and efforts to acquire and develop the resources and capabilities needed to integrate them; b) the benefits provided by the PIPE were greater than those acquired by the enterprises that did not resort to it; and c) the appropriation of these benefits provided faster results for the enterprises that obtained PIPE support.

The theoretical basis used in the study was the RBV, which proved to be adequate to support the study, since it enabled the clear and objective description of the resources and capabilities of the research enterprises. This approach facilitated the communication with the entrepreneurs during the interviews and helped in the subsequent analyses, which allowed high productivity in the development of the study.

Among the limitations of the research that underlies this article is the fact that enterprises with very different products participated, since a product could be up in the space of time that the study was carried out, weakening the understanding of its success.

For future studies a suggestion is to choose enterprises from the same industry to check whether the results would be more reliable. Another suggestion is to verify whether enterprises providing services or other businesses in which the technological dimension is not the essence of the business or the capability for adaptation is not so necessary could present another degree of importance of the resources and capabilities or of the unique conditions of departure or whether perhaps they were not so dependent on the previous experience of their leaders.

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