

ORGANIZATIONAL STRUCTURES TO SUPPORT INNOVATION: HOW DO COMPANIES DECIDE?

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RESUMO (português)

O propósito deste trabalho é discutir a questão de como as empresas que desejam aumentar sua capacidade inovadora devem tomar decisões sobre sua estrutura organizacional. Para atingir este objetivo, revisão bibliográfica sobre o tema foi realizada, bem como pesquisa de campo conduzida através de estudo de caso em uma empresa brasileira do setor petroquímico que havia recentemente reorganizado suas estruturas voltadas à inovação. Os resultados sugerem que a empresa estudada decidiu sobre sua estrutura organizacional sem considerar o processo de inovação como um todo, concentrando seus esforços na área de Pesquisa e Desenvolvimento. Sua estrutura é baseada em formas tradicionais de organização, com decisões centralizadas e funções bem demarcadas. Uma estrutura mais informal, adhocrática, que considere a inovação como um processo integrado poderia aumentar sua capacidade inovadora no futuro.

Palavras-chave: Estruturas organizacionais, inovação, capacidade inovadora, indústria petroquímica

1. INTRODUCTION

This paper attempts to discuss how companies seeking to increase their innovative capacity should make decisions regarding innovation-related structures. In order to do so, the relevant literature was reviewed and an exploratory study of a Brazilian petrochemicals company that recently reorganized its research and development structure, seeking to increase their competitiveness in product innovation was conducted.

Innovation, whether related to products, process, organizational methods, or marketing, is a complex, multidisciplinary activity that involves several areas of a single firm (such as Marketing, R&D, Manufacturing, Financial, etc.), its clients, and its suppliers. In order for this system to function effectively, effective coordination of the different activities it entails is required.

Traditional organizational configurations, which have Taylor, Fayol, and Weber as their main scholars, are based on the principles of division of labor, the need for supervision and a single center of authority and control. Such organizations would be static, as they should be efficient and effective in any situation (Takahashi & Takahashi, 2006).

However, in more turbulent, complex, and uncertain environments, such as innovative ones, static organizational frameworks with rigid division and specialization of labor cannot provide the flexibility and agility needed to maintain innovative competitiveness. Organization and communication structures that encourage and make use of experience-based learning, knowledge sharing, and interaction – such as project teams, problem solving groups, and task rotation – can contribute positively to the performance of innovative activities (Jensen *et al.*, 2007, Gloet & Terziovski, 2004).

Although the literature offers several examples of organizational configurations that prioritize the flexibility and agility required for innovative activity (Brown & Eisenhardt, 1997; Worley & Lawler III, 2006; Mintzberg, 1995), many companies adopt decision-making and coordination structures and methods based on classical theory, and eventually have trouble managing innovation efficiently and effectively, even though it is a vital strategic goal.

In seeking a path to effective and efficient innovation management, many companies design new structures and organization methods based on the assumption that their problems are similar and that solutions found in the literature are applicable, without adequately pinpointing the actual location of the innovation bottleneck. Hansen and Birkinshaw (2007) propose a framework – the “innovation value chain” – through which they conduct an integrated analysis of the innovative process, from inception of the concept to the diffusion of innovation across other areas of the firm, and propose that, prior to the implementation of changes, an exact diagnosis of the innovation-related issue and where it is located within the company be obtained.

In this context, the following question arises: *How should companies seeking to increase innovative capacity make decisions regarding innovation-directed structures?*

This study attempt to discuss some of the main issues faced by one such company in the search for more and better innovation, and just how much structural and organizational matter contribute to these issues. It will also analyze the organizational project proposed by the company as a solution for these problems – and the criteria employed in making the decision to adopt it – in light of the relevant literature, particularly models discussed by Hansen and Birkinshaw (2007) and Jensen *et al.* (2007), and assess whether the proposed solutions could indeed be effective.

2. CONCEPTUAL BASIS

Organizational project – “Classical” approaches to organization and why they don’t work in turbulent environments

The typical company organized according to the standards of the so-called “classical school” of organization (that structured around the theories of Taylor, Ford, Fayol, Mintzberg’s “machine bureaucracy”, etc.) is characterized by high-scale manufacturing of standardized products in assembly lines, or by more diversified production with a somewhat lower degree of operational integration through functional arrangements; such organizational structures may work quite well in predictable, growing markets, but would be of little use in more turbulent, complex, and uncertain environments such as those where innovation is ongoing (Zarifian, 2001; Salerno, 2009).

The classical approach to an organizational project has as its cornerstone the existence of an “optimal” organization, immune to the influence of environmental variables. The set of principles underpinning organizational structure should be efficient and effective in all possible situations (Takahashi & Takahashi, 2006).

Besides, the classical organization has among its characteristics the division of labor, the need for supervision, and the need for unified authority and control, as well as highly formalized behavior and vertical and horizontal specialization of labor. These characteristics, added to an internal division into separate, isolated units, make the classical organization extremely slow and inflexible when it comes to decision making (Mintzberg, 2003; Salerno, 2009).

These organizations are structurally geared towards maximizing efficiency – in their use of resources, economies of scale, and high-volume production of standardized products, all of which are typical characteristics of stable environments with a low degree of competitiveness.

However, in a growing number of sectors in the economy, the strategy used to obtain sustainable competitive edges is based on offering a varied range of products, on the embedded service concept, and on product and process innovation. Under this “new” competitive paradigm, an organization of labor based on the classic concepts – standardized tasks and job descriptions followed to the letter – would no longer be adequate, especially as it cannot meet the demand for greater agility and flexibility in decision-making, does not foster cooperation between employees, and does not promote knowledge development and individual learning, which are essential elements in the development of innovation (Zarifian, 2001; Salerno, 2009; Takahashi & Takahashi, 2006; Jensen *et al.*, 2007, Raisch *et al.* 2009).

An innovation-directed organizational project – flexibility and agility requirements

The most successful companies when it comes to product and process innovation are those whose organizational structures foster the development of knowledge through formal research and development processes and the development of knowledge based on experience, practice, and interaction between employees, clients, and suppliers (Jensen *et al.*, 2007).

As mentioned in section 2.1, the classical organizational configurations are not very appropriate for companies that have superior product and process innovative performance as their organizational strategy.

More flexible and agile structures are required, structures that allow interaction and communication between employees, without rigidly defined functional areas, and with functional integration instead. This “adhocratic” or organic structure would permit the development of knowledge based on practical experience and interaction, consequently leveraging the organization’s innovative capacity (Jensen *et al.*, 2007). This organizational configuration would also be the most readily able to handle events, as defined by Zarifian (2001) – that is, to deal with unforeseen actions and chance occurrences, which are characteristic of innovative environments.

Although there is no established organizational structure paradigm for such environments, several authors – such as Brown and Eisenhardt (1997), Hatchuel and Weil (1999), and Worley and Lawler III (2006), Raisch *et al.* (2009), Visser *et al.* (2010), – have discussed organizational characteristics of companies operating in innovative environments. Among the cited authors, the consensus seems to be a need for flexible organizations capable of responding to environmental changes, with greater interaction and communication among employees, greater decision-making agility, and more flexibly defined roles.

In his landmark book on organizational configurations, Mintzberg (2003) states “adhocracy” is strongly connected to providing innovation. It is not inspired by classical principles, and is

particularly distant from the concepts of unified command, high behavioral formalization, and planning and control systems. It is defined as follows:

- Organic structure, made up of ad-hoc project teams;
- Low degree of formalization;
- High degree of horizontal specialization of labor, based on formal individual knowledge;
- Mutual adjustment between teams, without the need for formal coordination of roles;
- No standardization of products or processes;
- Decentralized decision-making for inter- and intra-team activities.

Jensen *et al.* (2007), Biedenbach & Soderholm (2008) and Gloet & Terziovski (2004) maintain that the organizational configuration of companies that develop knowledge based on practical experience and interaction among employees would present with the following characteristics, some of them matching Mintzberg's adhocratic structure:

- Existence of interdisciplinary workgroups;
- Role integration around specialties and processes, rather than departments;
- Flexible boundaries between departments;
- Cooperation with clients.

The Innovation Value Chain framework

Although there is a relative consensus in the literature that the classical model of the organization is not the most appropriate for innovative companies, on the practical side there is no consensus on which paradigm should be used; different companies have different needs for flexibility and integration, operate in different markets, or operate with different logics (Salerno, 2009).

When trying to restructure themselves in order to become competitive, however, companies tend to adopt standardized organizational solutions, presuming that all companies face the same challenges when innovating. In fact, by adopting a standardized solution without assessing its applicability to their reality, companies run the risk of hampering innovation instead of encouraging it (Hansen & Birkinshaw, 2007).

In discussing this issue, Hansen and Birkinshaw (2007) propose the "innovation value chain" framework, which provides an integrated analysis of the innovative process, from the inception of a concept to the diffusion of innovation throughout company sectors, and establish that, prior to the implementation of changes, the innovation-related challenge and its location within the company should be pinpointed.

This framework analyzes the innovation process as a chain of integrated activities, somewhat similar to Porter's value chain. This approach favors the development of an integrated view of the innovation generation and development process, rather than one restricted to R&D efforts, as is common practice in the literature and in companies themselves, as well as for public policy-makers (Jansen *et al.*, 2007).

The innovation value chain is divided into three stages:

- **Idea Generation:** The development of product or process concepts within the organization, or by the initiative of clients or suppliers. The more closely integrated these players are, the more likely ideas are to surface.
- **Conversion of Ideas into product or process projects:** Generated ideas are selected, that is, a decision is made on which ideas are worthy of development, and projects to develop them are set in motion.
- **Diffusion of Idea across the organization:** Diffusion of the innovation throughout the company and its market.

To the authors, a new model of innovation would only be successful if, prior to implementation of changes, a precise analysis be conducted on the nature of the innovation problem and its exact location within the company. The innovation process should therefore be analyzed in the company as a whole, and not in a single sector (usually R&D) alone.

Synthesis of conceptual foundations

Based on the studies reviewed and the research dimensions identified, Table 1 summarized the constituent variables of innovation-directed structures that can withstand the instability of innovative environments, their definitions, and the indicators chosen to evaluate them in the fieldwork portion of the present study.

Table 1 – Key elements of innovation-directed organizational structures

Characteristics	Definition	Indicators in company (Jensen <i>et al.</i> , 2007; Hansen & Birkinshaw, 2007)
<i>Analysis of the innovation value chain</i>	Assessment of which step in development constitutes the innovation bottleneck. Changes should be made considering the critical step and viewing the organization as a whole. <i>Hansen & Birkinshaw, 2007</i>	- Steps critical to innovation: <ul style="list-style-type: none"> • Idea Generation • Conversion • Diffusion
<i>Flexibility and agility</i>	Adhocratic, organic, flexible structure, readily reacting to	- Decentralized decision-making - Low degree of formalization

	<p>“events” and adapting to constantly changing environments</p> <p><i>Mintzberg, 2003; Zarifian, 2001; Brown & Eisenhardt, 1997; Worley & Lawler III, 2006; Hatchuel & Weil, 1999; Raisch et al, 2009</i></p>	<ul style="list-style-type: none"> - Mutual adjustment between teams - Professionals specializing in their field, grouped by specialty - Integrated units - Flexible department/unit boundaries - Project teams with no unit coordination - Cooperation with clients
<i>Communication</i>	<p>Innovation-directed structures should foster the development and diffusion of knowledge through experience and interaction. Such knowledge boosts the company’s innovative capacity</p> <p><i>Jensen et al., 2007, Gloet & terziovski (2004), Biedenbach & Soderholm (2008)</i></p>	

3. METHODS

The question of how companies decide on an innovation framework is still poorly defined and established in the literature, particularly with regard to variables and theoretical constructs. The research theme may therefore be considered to still be at the theory building stage. Use of the case study as a research method is particularly useful when there is no certain definition for the constituent constructs and variables of the theory that would explain a given phenomenon (Voss *et al.*, 2002).

The present study will therefore be of a qualitative nature, and carried out through the case study method. Nonetheless, qualitative research has its disadvantages. The first is greater difficulty in assessing the validity and reliability of results. Another disadvantage of such studies is the possibility of becoming excessively complex and overly detailed, which would hamper identification of the relationships most important to the construction of a theory. Finally, qualitative, case study-based research may lead to non-generalizable results, as only part of the phenomenon is being studied (Eisenhardt, 1989).

Despite these drawbacks, qualitative case study research is, according to Eisenhardt (1989), the best choice for research in the initial stages where little is known of a given phenomenon.

The chosen study subjects were two projects developed in a petrochemicals company rated as innovative by the *Índice Brasil de Inovação*.¹ Further analysis was conducted on the company’s

¹ The *Índice Brasil de Inovação* (Brazil Innovation Index) is based on data from the *Pesquisa Industrial de Inovação Tecnológica* (Industry Technological Innovation Survey, PINTEC-2003/IBGE) and the *Pesquisa Industrial Anual* (Annual Industry Survey, PIA-EMPRESA-2003), provided by the companies, and complemented by patent data provided by the *Instituto Nacional de Propriedade*

organizational structure for innovation, before and after a major restructuring undergone in August 2007.

Following procedures proposed by Yin (2002), three data collection sources were used for the case study, namely, documentation (provided by the companies and obtained at its website), interviews, and direct observation.

Interviews are the most important source of information for the study. Through the use of semi-structured questionnaires, individual interviews with executives from the company's Research and Development, Technology, and Manufacturing departments were conducted.

A two-dimension approach was made to analyze interview data:

1. *Innovation-directed organizational structure before and after restructuring* – in order to verify whether the new structure features the innovative organization elements identified in Table 1.
2. *Analysis of two projects developed by company* – in order to assess which innovation generation and development process the company follows and which is the critical step in this process, according to the framework proposed by Hansen and Birkinshaw (2007).

4. DESCRIPTION OF STUDIED CASES

The subject company

Our study case is one of the largest chemicals and petrochemicals manufacturers in Brazil. Its products are used in the production of cosmetics, detergents, paints, PET bottles, textiles, and agrochemicals, among other markets. It has 5 plants in Brazil, 2 abroad, and exports to over 40 countries. It is recognized by the market as an innovative company, and holds 25 patents in Brazil and overseas.

For over 30 years, the company has produced petrochemicals, commodity chemicals, catalysts, and specialty chemicals (mainly surfactants). With growing international competition and high oil prices, the profitability of basic chemicals has been decreasing over the past few years; the company is therefore attempting to shift its focus to the specialty chemicals market. In this scenario, product innovation has become critical.

The company's corporate culture has always been directed at operational excellence, focused on production cost efficiency. Although operational excellence is still strategically important to the company, its management also believes that a stronger innovation-driven culture is necessary.

Although the company has obtained good results on the innovation front over the past years, it can still be considered conservative with regard to its willingness to take the risks inherent to

innovation. This stance may be partly explained by the sector's characteristics. The firm operates in a segment where the investment required to develop a new product is high and amortization periods are long; consequently, innovation proposals require greater maturity.

The company allocates approximately 2% of its net earnings to RD&E (Research, Development and Engineering), above the Brazilian average and that of its sector.² Around 12% of its staff (approximately 140 people) is involved in RD&E activities. Of these 140, 28% have a trade education, 61% have undergraduate degrees alone, and 11% hold graduate degrees.

Innovation structures

A basic organizational chart of the company may be found below (Figure 1). The RD&E role is performed by three structures within the firm.

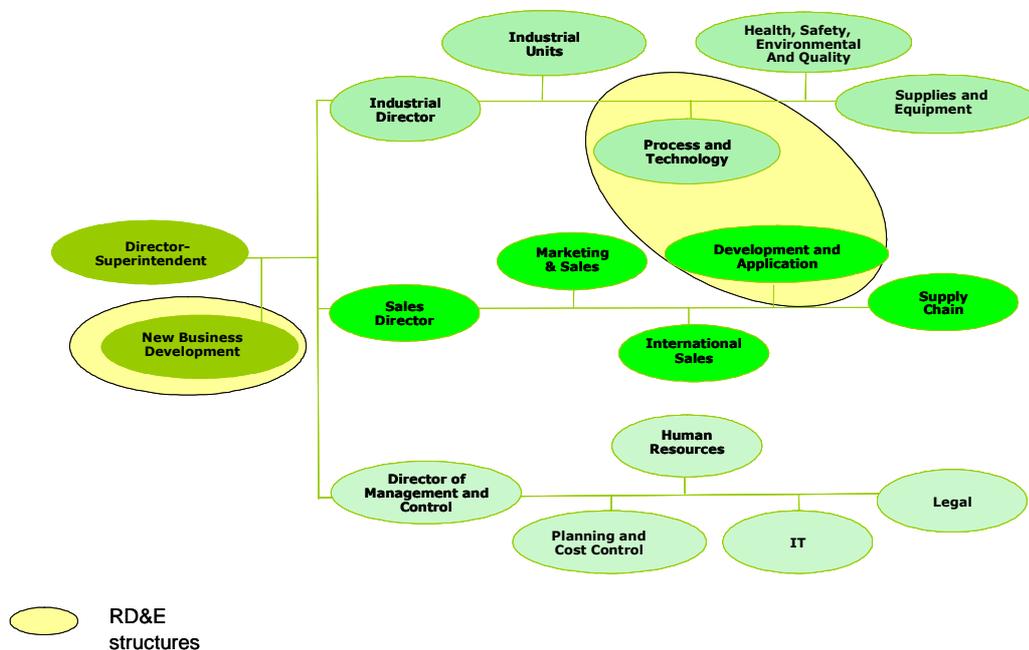


Figure 1 – Simplified organizational chart of study company

Source: Study data

The *New Business Development (NBD)* area, directly connected to the company Superintendency, is responsible for identifying new market opportunities in technologies already existing in the company or the market, and also for developing new scenarios or technologies, such as alcohol and oleochemicals. This area is also in charge of developing long-term operation strategies and projects.

The *Development and Applications (DA)* area, connected to the Commercial department, is in charge of the technical development of new products or new applications for products the company already manufactures. It is structured according to the target market segments of the

² Average technological intensity (as measured by relative R&D spending over earnings) of the 20 most innovative industrial activities in Brazil is 1,0%. Data source: IBGE, Pintec 2003.

company's products, and divided into departments: Food Additives, Agrochemicals, Personal Care, etc. The company also has laboratories that provide analytical research support and a technical information center, which conducts scientific literature and patent searches. Until recently, it focused on market needs identified by department technicians or by Sales and Marketing personnel

The *Process and Technology* (PT) area, attached to the Industrial department, is directed at the development of new processes to meet the needs identified by staff at Application or New Business. This department also includes the Catalyst Development area, which follows its own product development process, due to the specificity of its products.

The company has an internal group, known as the Technological-Scientific Committee, which assists the development of technological strategies. It is composed of academic researchers and specialist consultants of the petrochemicals industry, both Brazilian and from other countries. This committee convenes every six months or so to discuss future trends in the sector and suggest strategic technological directions for the company.

The selection of projects to be developed is conducted by an executive committee composed of members of the company's Board of Directors. There is a concern that short-term projects are selected more frequently, due to the prospect of more immediate gains; implementation of a method to aid decision-making in the project portfolio, to balance out selection of medium- and long-term projects, is currently under study.

Innovation structures are well defined, and based on the company's functional organization. The new product development process is structured into and defined by operating procedures, with given responsibilities allocated to each functional unit.

The manner in which product development was structured revealed a concern with meeting short-term needs. Company specialists were assigned to service specific market segments, and focused on solving urgent problems presented by their clients.

Although the company's clients (particularly innovative clients with a well-developed R&D structure) were important sources of ideas for innovation, the focus on meeting the needs of each specific segment did not allow the development of knowledge on a specific technology; in-depth knowledge of each client's business was building instead, which inhibited the company's capacity to develop alternative solutions or use these solutions in diverse market segments.

The company's management understood that this excessive focus on customer service was the greatest barrier to implementing a strategy of specialty chemicals innovation, and directed a restructuring of the innovation function oriented to solving this.

Restructuring was carried out exclusively in the Development and Application department. The department's former structure of separate management units directed at specific markets was replaced with division into "R&D Project Cells", which are organized by product class – each cell handles R&D for products with related chemical structures –, allowing development of products that meet the needs of various markets, and focusing particularly on the development of new products.

Customer service was delegated to the "Client Assistance Cell", a new area focused on providing services such as developing applications for existing products. The company predicts that these areas' activities will be connected by a new unit to be called the "Information Cell", which will be in charge of researching technical literature (patent and literature searches, research network searches) and managing knowledge developed by the R&D and Assistance cells.

Analysis of 2 projects carried out by company

To gain a better understanding of how the company's departments are interrelated, two projects carried out by the company were studied: the development of a new product (NP1) and modification of an existing product (NP2).

The company's new product development process from idea inception to the implementation of the new product (or process), may be briefly described as shown in Figure 2 below. Depending on the type of project, the outlined steps may be executed simultaneously, and their duration depends on the type of product, its degree of novelty, and the resources required – the development of a new molecule, requiring new process, for instance, may take up to two or three years.

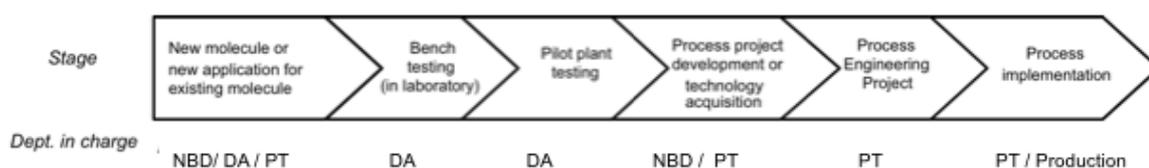


Figure 2 – Simplified new product development flowchart
Source: Study data

NP1

NP1 was the result of a client's technical need: a personal care products manufacturer wanted to develop a product with particular characteristics. To do so, it required a more effective mechanism for dispersion of the product, which could be developed by our case company within its Surfactants area.

A new molecular entity was developed from a basic product manufactured by the company, which required a great deal of bench work, that is, laboratory research. Once the target molecule

had been identified, development of the manufacturing process began at the laboratory level, in which reaction conditions (such as speed, selectivity, temperature, etc.) are analyzed. Pilot-scale testing followed – testing under conditions similar to those found in industrial-scale manufacturing, but at a reduced production volume. This phase was conducted by the Development and Application department.

The next step involved development of the manufacturing process and technology, coordinated by the Process and Technology area. For an optimal development timeline, industrial-scale testing was conducted simultaneously with development of the manufacturing technology. Upon starting industrial production, there was significant pressure regarding deadlines and production volume, which led to a reduced period for learning and error correction. There were difficulties in implementing the manufacturing process, which was unstable; ultimately, the product did not conform to the client's expectations and was the object of several complaints.

The production manager believed there was little department involvement in the product's development. Some specifications, which could be met in the bench or pilot scale, could not be carried over to industrial-scale manufacturing, which led to a request for changes in the desired specifications.

NP2

NP2 consisted of a modification of an existing product, manufactured for use in the food industry. The initial concept was created by the company's own initiative, seeking to increase performance relative to similar products manufactured by competitors.

As NP1, NP2 was developed on a bench and pilot scale by the Development and Application department, with little involvement of the Process and Manufacturing areas.

After six months of industrial-scale production, NP2 was considered the company's "top product" with regard to noncompliance with specifications – it even failed to meet its predetermined production cycle deadline. As with NP1, modifications to the product's specifications had to be requested.

Table 2 below summarizes the data obtained at the company.

Table 2 – Innovation-directed organizational structure elements found at studied company

Characteristics of innovation-linked structures	Indicators in company	Indicators found at case company
<i>Analysis of the innovation value chain</i>	- Steps critical to innovation: <ul style="list-style-type: none"> • Idea Generation • Conversion • Diffusion 	- <i>Conversion</i> and <i>diffusion</i> could be considered the critical steps, as shown by the analysis of NP1 and NP2.
<i>Flexibility and agility</i>	- Decentralized decision-	- Decisions centralized in those responsible for

<i>Communication</i>	making <ul style="list-style-type: none"> - Low degree of formalization - Mutual adjustment between teams - Professionals specializing in their field, grouped by specialty - Integrated units - Flexible department/unit boundaries - Project teams with no unit coordination - Cooperation with clients 	each functional unit <ul style="list-style-type: none"> - Formalized behavior with rules and procedures for innovative activity - R&D professionals grouped by specialty - Functions separated into departments and management units - Well-defined functions; strongly bounded responsibilities and roles, separated by area - Project teams are present, but are coordinated by functional area. - Clients propose ideas and assist in the innovation process; client relationship was considered overly focused on short-term projects. R&D and Customer Service are separate areas.
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5. DISCUSSION AND CONCLUSIONS

Analysis of the study cases revealed that, despite restructuring of its R&D area, the subject company still features many characteristics of “classical” organizations, and very few elements found in agile, flexible firms. Of the eight key elements of innovative organizations found through review of the literature, the company shows only three – project teams, R&D professionals, grouped by specialty, and a cooperative relationship with clients.

The company’s innovation model, according to Jensen *et al.* (2007), may be described as strongly based on R&D investment, with little emphasis on innovation generated by employees’ tacit knowledge.

This may be explained by the sector in which the company operates, which is highly dependent on specialist technical knowledge, but according to Jensen *et al.* (2007), tacit knowledge and communication among employees help leverage innovative capacity even in high-tech companies with a strong profile of technological innovation.

Restructuring of the company’s innovative activities was restricted to the R&D department and focused on idea generation, according to the framework proposed by Hansen and Birkinshaw (2007). Nonetheless, evidence found on assessment of the NP1 and NP2 projects revealed the existence of bottlenecks in the conversion and diffusion stages, particularly regarding R&D interface with the Process and Technology and Manufacturing areas, which negatively impacts indicators such as total performance time.

There was no visible concern on the part of the company with analyzing innovation from a holistic standpoint – that is, viewing the organization as a whole; analysis of challenges to innovation was restricted to R&D activities. The organizational project used in subsequent restructuring was also restricted to challenges faced internally in the R&D unit, concerning the

difficulty in generating ideas and what the company felt was an excessive focus on providing short-term solutions as requested by clients.

With the possibility of greater efficiency in project generation, one may speculate that a consequent increase in the volume of ideas could create bottlenecks in project selection and difficulties in implementing the manufacturing process, according to the model proposed by Hansen and Birkinshaw (2007).

Although the literature presents various recommendations about the type of organisation required for the development of innovation as a whole process in established companies, these suggestions are too generic and superficial. Most evaluations lack well-established and widespread models or managerial tools recommended for product development processes, such as the Clark and Wheelwright (1993) innovation funnel.

An organizational project that considers the company as a whole and provides particular focus on the interfaces between different company areas involved in innovation development, according to Sitter, Hertog and Dankbaar (1997) and Salerno (2009), could theoretically solve this issue. A greater involvement on the part of the Manufacturing and Process departments during the development stage and greater interaction with the R&D area could improve project performance, particularly concerning deadline compliance and implementation costs.

This paper's research question – *How should companies seeking to increase innovative capacity make decisions regarding innovation-directed structures?* – Could be answered as follows: According to the literature reviewed, companies should decide on an innovation structure taking into account that the creation of knowledge through practical experience and interaction could increase capacity to develop product or process innovation.

Also, when planning organizational structure, companies should consider which step of the innovation development process is most critical, as isolated modifications not viewing the company as a whole could cause more trouble to the innovative process; let alone provide desired solutions to existing challenges.

The evidences of this case study, though not amenable to generalization, show that the petrochemicals company analyzed here decided on modification of its organizational structure without taking a global view of the innovation process, that is, it focused its efforts on the R&D area alone, seeking increased efficiency in that particular unit and not in the innovation process as a whole. The company's innovation paradigm is still strongly based on formal, explicit knowledge of specialists in the field and R&D contributors, without consideration for the practical experience of line personnel – admittedly, reasonably so, considering the sector in

which it operates. Practical knowledge could, however, help the company develop greater innovation through more efficient processes.

This evidence suggests the need for more extensive analysis, of companies in the same sector or other medium- to high-tech sectors, to verify whether results would corroborate those found here and also to improve upon the measurements employed in this study, which could be of use to later, more quantitatively robust studies.

This study sought to contribute to discussion on the theme of companies' internal innovation structure, which is still largely unexplored in the literature when compared to broader levels of innovation (global or national), or in micro level, as the studies about organization for Research and Development structures. More in-depth research in this area could contribute to increased knowledge of factors capable of improving the innovative performance of Brazilian companies.

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