

Product development management in small technology-based firms: cases in the medical and hospital equipment sector

Glauco Henrique de Sousa Mendes

Federal University of São Carlos

ghsm@uol.com.br

José Carlos de Toledo

Federal University of São Carlos

toledo@dep.ufscar.br

Abstract: High technology-based firms are synonymous with technological innovation, either incremental or radical, which makes new product development (NPD) a critical process for these organizations. This article proposes to identify and analyze the main practices and problems in NPD management in enterprises of the medical and hospital equipment sector. The research method was based on two case studies, involving structured interviews with representatives from product development areas. Our findings contribute to a better understanding of the practices adopted by such firms, from the standpoint of strategy, organization and practices in New Product Development, highlighting problems and trends detected in this area.

Keywords: product development management, technology-based firms

1. Introduction

This work deals with a special type of organization: high technology-based small firms (HTSF) in the medical and hospital equipment sector. The HTSFs are closely associated to technological innovation, either incremental or radical, transforming NPD (New Product Development) into a critical process. As a premise, NPD should focus on the market and be aligned with competitive, technological, quality and product strategies of firms. Therefore, HTSFs should recognize and deal with the uncertainties of the external environment in its economical, political and technological aspects, which highly influence their behavior. HTSFs capability to control these aspects is minimized, given their small sizes, according to the profile of HTSFs selected for this work.

In the operational level, NPD success, among other factors, depends on the division of the process into well-defined stages, supported by human, material and methodological resources. All these factors denote the complexity inherent to NPD management in the high technology firms.

Various strategies, methodologies and tools are being used in development process management, endeavoring to improve factors such as development costs, time-to-market, manufacturability and to guarantee that the products attributes are devised to attend the consumer's necessities. However, emphasis is given in the analysis of this process in large firms.

Normally, studies regarding HTSFs concentrate on subjects like technological transfer, relationship with universities, formation of clusters and subsidies for innovation. There is plenty of literature concerning NPD management, although it is mainly directed to large enterprises. Therefore, there is a lack of studies concerning NPD management in HTSFs due to the existing gaps in academic research and the importance of this process for the success of HTSFs.

The aim of this article is to characterize the management process in New Product Development in small firms which manufacture medical equipment. In order to do this, the case study method was used. Information was collected from interviews to be used in questionnaires with questions referring to the general characteristics of each firm, its structure, management procedures, problems and trends regarding NPD process. The interviews were carried out with

the people responsible for the NPD area, which, in the investigated cases, were the companies owners themselves.

This article is organized in six sections. In the next section, the characteristics of HTSFs will be presented. A brief review of NPD is given, concluding the theoretical basics of the article. In the fourth section, the results regarding NPD management in two HTSFs are described. At the end, we have the final considerations.

2. High technology small firms

The definitions for technology-based firms found in the literature are quite similar. FERRO & TORKOMIAN (1988) use the expression "high-technology companies", distinguishing them from others, in terms of the technological hierarchy aspect. According to these authors, this term designated companies that incorporated a high level of knowledge in processes and economically viable products. In order to define small and medium-sized Brazilian HTSFs, FERNANDES et al. (2000) highlighted the following main facts:

- New products that reflect new technology, developed inside a company or in partnership with other companies or research centers. However, the product must be on the market, be economically viable and it must have been created having scientific knowledge as a basis;
- A policy of investment in research and development and concentration of specialized human resources, despite being of a lower level when compared to developed countries. Regarding this, it is important to emphasize the presence of an organizational area, formally constituted or not, which is responsible for the tasks related to the innovation process; and
- A close relationship with universities, research centers and other innovation networks, aiming to accumulate knowledge and improve competences related to innovation.

The SEBRAE/IPT (2001) presents a short definition, which indicates that the HTSFs are engaged in the project, development and production of new products and/or processes, characterized by the systematic application of technical and scientific knowledge. Moreover, they use innovative technologies, have a high proportion of expenses within R&D, they employ engineering and technical-

scientific personnel at higher rates than the traditional firms and they operate in sectors or niches which are refused by big companies.

This definition is very symmetric to others, differing only in the direction of the market which is traditionally explored by HTSFs. It highlights the HTSFs involvement with activities of significant technological qualifications and the focus of their operations on manufacturing “new” products.

3. The new product development process

According to CLARK & FUJIMOTO (1991), the product NPD process transforms the data concerning market opportunities and technical possibilities into goods and information to manufacture a certain product. According to the authors, the way in which a company organizes and manages product development determines the gain of competitive advantages.

Several authors (CLARK & FUJIMOTO, 1991; CLARK & WHELWRIGHT, 1993; GRIFIN, 1997) try to identify the factors that exert significant influence on the NPD performance. The main points are: team-work; the leadership model adopted when carrying out projects; the involvement of clients and suppliers in PD; carrying out the development stages and the technical and managerial competence of the people involved in product development at the same time.

As well as the critical factors concerning success, the NPD dimensions should be considered to understand this process. ROZENFELD et al. (2000) describe the NPD process in terms of four dimensions: strategy, organization, activities/information and resources. The NPD management structure regarding the aspects mentioned by these authors produces a common referential that assists its management by articulating innovation with other organization strategies by facilitating the communication between the members of the development team (internal and external) and by permitting the implementation and integration of methods, techniques and support systems in the innovation process.

Topics such as portfolio management, performance evaluation, partnership integration and development mold the strategic aspect and determine the NPD nature to be adopted by the organization.

The organization aspect consists of organizational and behavioral perspectives. The first perspective deals with the choice of designs used in the NDP organization. Leadership is also part of this aspect. The other perspective is related to carrying out group-work and deals with the involvement and cooperation among development team members. The learning perspective addresses questions concerning qualification programmes and organizational learning.

The “activities” aspect deals with the NDP structure in terms of stages/activities carried out by the firm, as well as the information related to doing each of these activities.

The resources aspect consists of techniques, methods, tools and systems adopted in previous aspects, which has an instrumental and operational approach. Statistic and organizational methodologies, whose choice and application depends on the necessities of each company and on the specific characteristics of the kind of innovation, can be highlighted.

4. Case studies

In this article, two case studies in HTSFs of the medical equipment sector located in the city of Ribeirão Preto, considered as being important in this sector, were carried out. The names of the firms were confidential, as requested by them. The identification of each firm is as follows:

- Firm A is a Brazilian/national capital firm and has been in the market since 1985. From its beginning, it has focused on the electro-surgery sector, developing and manufacturing products such as: micro-processed electronic scalpels, argon plasma coagulators, inhalers and monitors for cardio-fetal heart beat and blood flow; and
- Firm B is a new and also national capital firm. Its product range includes the following kinds of equipment: pre-natal equipment, respirators, surgical and obstetrics procedures and patient monitoring.

The results obtained will be discussed in the next sections and summarized in tables that make the comparison between the investigated firms easier.

4.1. General data of firms

According to what can be observed in Table 1, there are many similarities between the firms: both have the same capital (national) origin; they are classified as small-sized firms (SEBRAE) and they decide on similar strategies of product innovation. Despite this, the firms assume different points of view concerning market strategy.

Firm A invests in the product differentiation, having technical quality as its main competitive advantage in relation to its national competitors. Nowadays it is the market leader in the main sectors it works in, which enables it to establish strategies for *premium/higher* prices for its products. Company B is in the position of offering low-value-added products in order to achieve competitive prices in the market, since it has the Government and public hospitals as its main customers.

Table 1. Description of the Firms.

Factors	Firm A	Firm B
Origin of capital	National	National
Number of employees	45	20
Market strategy	Product Differentiation	Low cost
Exports	Yes	Yes
Strategies for technological change in their products	Bigger and less frequent changes	Bigger and less frequent changes
% of revenue from new products (within 5 years)	60 to 80%	80 to 100%
% of revenue invested in PD (within 5 years)	10%	> 20%
Has a PD department	Yes	Yes
Number of employees in PD	3	3

When we consider globalization/internationalization strategies, we can observe that both export, with company A obtaining 25% of its revenue from sales to countries like China, Mexico and Russia (its main markets) and company B obtaining 7.5% of its revenue with exports to Latin American countries (Colombia, Nicaragua and Equator). An important detail cited by the companies owners is that in international markets, where there is competition against the “big players”, Brazilian products are positioned in low-end market segments, which reveals the technological disadvantages in relation to the world leaders.

In relation to their policies for launching new products, both companies have obtained a considerable amount of their revenue with the introduction of new products in the last 5 years. Company A has launched 5 new pieces of equipment, while company B has introduced 7 products in the same period. According to the proprietors, most of the products launched are substitutions of former versions, i.e., few products can be classified as new in the market or in the company. Besides this, financial and legal restrictions (imposed by the regulatory body, such as product registration, quality testes, etc.) contribute to the adoption of a rate of technological innovation which favors bigger and less frequent technological changes.

Companies A and B have formally constitutes NPD departments, although they name them “R&D” and “Projects”, respectively. As it is characteristic of HTSFs, company B has a vigorous investment policy in this area. Nowadays, the percentage of revenue invested in NPD activities has reached more than 20% on average. In company A’s case, the average investment was between 5 and 10% of the revenue.

4.2. NPD management

To characterize the NPD management of the studied enterprises we chose the structure given by ROZENFELD et al. (2000). Thus, the principal perspectives which compose each dimension will be described according to the revision presented. Some results are demonstrated in Table 2.

In both companies, the management of the projects portfolio is made in a simple way. In company A, on average, four projects are developed simultaneously, and they are coordinated by the proprietor, who accumulates the Commercial and R&D areas. Annually, a plan drawn up by both the R&D and Engineering areas defines the projects

which will be developed. The follow-up is done in quarterly meetings, called Critical Analysis of Projects.

In company B, the Projects area is responsible for the conduction of the projects in progress, but the decisions about the resources allocation and the continuity are made by a committee composed by industrial and commercial area managers and technical direction (quality). According to the proprietor, the small size of the company enables agility, flexibility and absence of bureaucracy in the management of projects.

The selection of innovation projects in Brazilian HTSFs demonstrates the lack of formal procedures for risk analysis, which would support the decision of continuing or not with a project (PALMA et al., 2002). We can conclude that the portfolio management in the investigated companies is also done in a not-structured way. We can perceive that the term portfolio management is unknown by the interviewees, as well as platform and derivative projects. Both researched companies did not mention the preoccupation with formal methods of integration between the projects and the resources.

Links with universities are not being developed by the companies. Only Company B has been involved in a partnership with research centers for the acquisition of optical technology used in its products. Partnerships with supporting agencies which aim at obtaining a flow of investments which would guarantee the continuation of the research and activities of the company itself are desired but still inexistent. Other kinds of links and partnerships, mainly with suppliers and customers, were point out as the most significant. However, both companies have their own development as a source of technological development, making it clear that, in fact, they do not maintain close links with the academic community, as they claim.

Another perspective we can highlight concerning the strategic dimension is that the employee and functional relationships involve the integration, at strategic level, of the areas related to NPD (SILVA, 2002). Integration in companies A and B happens in an organic way, due to their small size, which facilitates the contact between individuals, and consequently, communication and exchange of information. As integration strategies, the companies mentioned the formation of multidisciplinary teams.

We can also observe the strong influence of the commercial area, responsible for giving information about the market to the NPD area. In company B, the commercial area’s evaluation regarding the ideas

Table 2. Dimensions of PDP management.

Factors	Company A	Company B
Strategy Dimension		
Portfolio Management	Not structured	Not structured
Average of projects developed simultaneously	4	3 to 4
Level of integration/relationship with other institutions	low	low
Guided by a team	Yes	Yes
Areas involved in the team	R&D, Commercial, Assembly and Quality	Projects, Commercial and Quality
Organization Dimension		
Project leader	Yes	Yes
To whom the leader responds	Partner	Partner
Settling used	Matrix	Matrix
Activities/Information Dimension		
PDP formalization	Yes	Yes
Model	ISO/GMP	ISO/GMP

for new products influences the decisions to maintain a project or not. Besides the commercial area, in company A, other organizational functions such as assembly and quality are also part of the project teams. In company B, representatives from the commercial, project and technical areas (quality) participate in the teams.

A key point in cross functional relations is the organizational design used. In this case, the companies were asked to answer questions about successful projects. Both companies used matrix structures, i.e., personnel from different areas participated in the development teams and reported to the project manager and to their functional manager.

In small firms, the entrepreneur's leadership determines the organizational dynamics. It is correct to affirm that in these firms, projects for new products are not initiated without the approval from the top management. In the same way, the development process is influenced by the entrepreneur's/manager's concepts and competences regarding the carrying-out of activities, communication patterns, human resources development and knowledge management. A common characteristic among the companies researched is the presence of a team leader. In company A's case, the proprietor is directly responsible for the execution of development projects. In company B, however, the control is done by the Project manager, followed closely by the owner.

There are many ways to classify the phases and activities of NPD process. One of the most classical views is presented by CLARK & FUJIMOTO (1991), who adopt the following sequence: product concept generation and choice, product planning, product engineering, process engineering and pilot production. Other authors (PUGH, 1996; PRASAD, 1996) present different versions for NPD steps. The activities dimension encompasses NPD process in terms of steps/activities developed by the company, as well as information related to their execution.

Research carried out by de TONI & NASSIMBENI (2003) showed that NPD in Italian HTSFs in the optical sector are characterized by the lack of emphasis in formalization. However, both investigated firms in the hospital-medical sector have formalized and documented procedures that define NPD activities.

Both companies have the ISO 9000:2001 already introduced. As they are manufacturers for medical equipment classified as Classes II, III (medium risk) and IV (high risk), they are required to establish and maintain procedures for project control, according to the requirements determined by the Good Manufacturing Practices for Medical Products (GMP). Thus, the activities followed by the firms are: planning and product development, data concerning the project start, project revision, end of project, transfer of project, project release, project alterations, historic register of project.

4.3. Problems and trends in NPD process

The research also aimed to verify the main problems faced in relation to NPD, as well as checking trends and perspectives in this area. The biggest problem is that the firms have difficulty to access universities and research centers for the joint development of new technologies and products. According to firm A, there is a gap between the company's needs and the university capability.

Another issue mentioned refers to the lack of resources to be applied in the R&D and NPD. One solution would be to cut the bureaucracy involved in the financing procedures. Problems such as poor qualifications of new employees (who need to be trained in the firm) and dishonest competition from products which do not meet the legal standards were also pointed out by company A.

Regarding trends, we can perceive that they do not have a clear view concerning the needs for the NPD area in firm B. In the future, the company intends to increase the number of commercial partnerships in order to ensure they will have a laboratory for product testing. They did not mention anything concerning personnel, resources for development, NPD management and use of tools and software.

Firm B, on the other hand, presented a clearer view. They intend to hire personnel for the NPD, acquire software used in development (fast prototyping), equipment for testing products, as well as partnership with foreign companies for the assembly of products abroad and also for better technology exchange.

5. Final considerations

A HTSFs capability to respond satisfactorily to the market demands depends on the generation of innovative products. This places NPD, whose good performance depends on the quality of its management, as a key factor for the survival and differentiation of this kind of firm.

HTSFs are engaged with the product, development and production of new products and/or processes. What characterizes them is the systematic application of technical and scientific knowledge. In addition, they should be identified from the following characteristics: innovative technologies, a high proportion of investment in R&D, a higher rate of employees in engineering and technical-scientific areas than traditional firms, as well as the working in segments or niches that are disregarded by big firms. Some of these characteristics were found in the firms researched.

The aim of this article was to present the NPD process management adopted in two HTSFs in the medical equipment sector. We observed that the behavior of the companies we analyzed differs from the results obtained by FERNANDES et al. (2000) regarding the existence of a specific area for NPD, although the reduced staff in both companies stresses the critical role of the technological entrepreneur as the main articulator of partnerships and the leader in development projects.

The model for PDP management should be integrated and coordinated with other strategies adopted by companies. The participation of different functional departments in the development activities was observed, specially the commercial area. The NPD itself is based on the Good Manufacturing Practices, a legal demand for some firms in the sector.

Potential problems were also identified. The management of various research projects and product development projects in the firms lacks a more sophisticated structure. Moreover, insufficient adoption of techniques and methodologies applied to NPD was observed, specially the more complex ones. Finally, the absence of a clear concept of the needs related to the various dimensions of NPD is a cause for concern.

6. References

- CLARK, K. B. & FUJIMOTO, T. (1991) - **Product Development Performance**: strategy, organization and management in the world auto industry. Boston, HBS Press.
- CLARK, K. B.; WHEELWRIGHT, S. C. (1993) - **Managing new product and process development**: text and cases. New York: The Free Press.
- de TONI, A.; NASSIMBENI, G. (2003) - Small and medium district enterprises and the new product development challenge. **International Journal of Operation Production Management**. V. 23, n. 6, p.678-697.

- FERNANDES, A. C.; CÔRTEZ, M. R.; OSHI, J. (2000) - Innovation Characteristics of Small and Medium Sized Technology-Based Firms. In São Paulo, Brazil: A Preliminary Analysis, Proceedings of **4th International Conference of Technology Policy and Innovation**; Curitiba, Brazil, August, 2000.
- FERRO, J. R.; TORKOMIAN, A. L. V. (1988) - A criação de pequenas empresas de alta tecnologia. **Revista de Administração de Empresas**, Rio de Janeiro, v. 28. n.2, p. 43-50, abr./jun. 1988.
- GRIFIN, A. (1997) - PDMA Research on New Product Development Practices: Updating Trends and Bechmarking Best Pratices. **Journal of Product Innovation Management**. Vol 14: 429-458, 1997.
- PALMA et al (2002) - Gestão da Carteira de Projetos: Um Estudo de Caso. **XXII Simpósio de Gestão da Inovação Tecnológica**, CD.
- PRASAD, B. (1997) - Concurrent Engineering Fundamentals, NJ, USA, Prentice Hall.
- PUGH, S. (1994) - **Total Design**. Wokingham, Addilson - Wesley.
- ROZENFELD, H.; TOLEDO, J. C.; AMARAL, D. C. (2000) - O Processo de Desenvolvimento de Produtos. **Revista Produtos & Serviços**. São Paulo: Banas, n. 312, p. 55-64.
- SEBRAE/IPT. (2001) - MPES de base tecnológica: conceituação, formas de financiamento e análise de casos brasileiros. **Relatório de Pesquisa**, julho de 2001.
- SILVA, S.L. (2002) - **Proposição de um modelo para caracterização das conversões do conhecimento no processo de desenvolvimento de produto**. São Carlos, SP, Escola de Engenharia de São Carlos, Universidade de São Paulo, 2002, 231 p. (Tese de Doutorado).

