Critical success factors on product development management in Brazilian technological based companies

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Abstract. In order to minimize the proportion of unsuccessful projects in new products development (NPD), managers have become concerned in understanding which factors have an impact on the success of new products. The aim of this paper is to identify and analyze the critical success factors (CSF) when developing new products in technological based companies (TBCs). The data was obtained through a survey in 62 small TBCs of two sectors: the medical and hospital equipment and the process control automation, in the State of São Paulo, Brazil. This has resulted in a sample of 62 new product projects considered successful and 42 unsuccessful, from the firms' point of view, developed in the last five years. The questionnaire was structured based on eleven management factors, deployed in 64 variables. The association of these variables with the project result (successful or unsuccessful) was measured through their respective contingency coefficients. Thus, we sought to determine which variables, considered in isolation, could explain new product's success. We also tried to reduce the individual variables by using factorial analysis techniques, where three main components were associated to new product success: target-market characteristics, execution quality of NPD activities and integration between the areas involved in NPD.

Keywords. Product development management, Technology Based Companies, Critical success factors.

1. Introduction

In the developing countries small and medium technology-based companies essentially operate within market niches, not occupied by the bigger companies,

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and normally to substitute imports. Nevertheless, their economic potential should not be neglected. Although TBCs may mostly be small sized, they frequently develop innovative products, and thus are likely to boost the economic growth in their operations regions [6, 12], influencing with their technological innovation culture both their partners, customers, suppliers and competitors.

Most field researches involving small and medium size TBCs in Brazil, according to [1] focus primarily the development of technological poles and business incubators. Thus, according to those authors, a lack exists of empirical studies which reveal management factors critical for the success of those organizations. Furthermore, Process Development is a process critical for those companies and barely known from the academic point of view.

The study of management of product development process (PDP) in small and medium size TBCs is yet in a beginning phase in Brazil. As attested by [9], those companies face significant managerial difficulties, influencing the success rate of the products they develop.

According to [8], best practices for small and medium companies can only be recommended upon consideration given to their peculiarities. Therefore, it is relevant to identify the management practices, taking into account companies of a specific industry, their size and peculiarities of their organizational structure.

Taking into consideration the context pointed at, the objective of this paper is to describe and analyze the main practices and success factors relative to PDP management in small and medium size TBCs operating in the Process Control Automation (PCA) sector, and Medical and Hospital Equipment (MHE). These sectors stand out for their proven technological dynamics found in Brazilian innovation research, in addition to their economic relevancy within the small-sized Brazilian TBC.

The concept of success and failure projects was based on comparison between a company's original expectation and the product's real performance in the market. During the research components associated to the market were investigated, such as technical factors and practices adopted in managing these projects, since such elements collectively influence the new project's success or failure.

The purpose of this paper is outline by this introduction. The following section discusses critical success factor in PDP management. Following are the research method, results and conclusions.

2. Critical Success Factors in the Management of the Product Development Process

A research line in the area of PDP management is finding success factors, namely, differentiating practices (tactics, methods, tools and techniques) that, provided they are thoroughly and well executed, contribute to increase the probabilities for success in launching new products [7]. Many authors [3, 11, 12] point out a set of factors associated to the success of new products.

According to [4], the first study in this field was carried out by the consulting company Bozz, Allen and Hamilton in 1968, which verified that almost 1/3 of the

products launched, ended up in failure. The vast amount of literature in the area produced a collection of factors associated to the success of new products [3, 12].

For the purpose of this paper the following factors were investigated: new product innovation degree, characteristics of the target markets, product characteristics, technology sources, company skills/ability, project leader skills, integration of PDP, PDP organization and execution quality of PDP activities. These factors are to be briefly discussed below.

The market orientation is critical to the success [3, 12]. This factor approaches aspects such as company capacity to evaluate market potential for a new product, understanding the needs of the target market and translating such information into PDP language [10].

There are numerous products characteristics that propel them to success: low cost, high quality, superior performance and unique attributes [2, 10]. The need to integrate the strategy of product development with company strategies at program and project levels is also recognized [2].

Technology sources can also contribute for the success or failure of a new project, because they demand acquisition, adaptation and managing skills [5].

The main organization aspects of PDP mentioned in the literature include the company organization for product development, the degree of integration between the functional areas, level of PDP structuring and characteristics of key-individuals involved in the project execution [10]. Reference [3] indicates five important factors linked to organizational characteristics of PDP: setting up multifunctional teams, authority and responsibility of the project leader, the scope of responsibility over the project by the development team, commitment of the team members and high degree of communication during the entire project.

Regarding to carrying out PDP activities, [10] recommend paying attention to the pre-development phase, handling of technical and market studies, and feasibility analysis. Reference [4] emphasizes the need for quality in activities concerning generating and analyzing ideas, technical development and market introduction.

As regards PDP management in TBCs, [13] indicate that many studies of product development are carried out in companies located in relatively stable vicinities, a quite different reality from the areas or markets where Technology-based companies (TBCs) are usually established.

3. Research Method

The research was projected in three phases. Initially, the bibliographic revision of PDP management, critical success factors in product development and in technology-based companies was accomplished. This phase enabled the formulation of a set of factors that could explain the success of a new product.

The second phase consisted of choosing the participating companies of the research and data collection. Based on criteria as size, operation segment (manufacturers of medical and hospital equipment and process control automation), location (Sate of São Paulo) and existence of their own and active PDP, the sample amounted to 62 TBCs, totaling to 104 products, out of which 62 were considered as successful and

42 considered as unsuccessful. Table 1 synthesizes the stratification of these projects/products according to the industrial segment.

Table 1: Project/ Product Classification

Product	***Success***	**Failure**
Medical and Hospital Equipment	30	19
Process Control Automation Equipment	32	23
Total	62	42

Success or failure was the denomination given by the answerer, who compared the performance of the product in relation to the company's expectations regarding the launching. In the cases where the performance was equal or surpassed expectations, they were classified as successful, however in the unsuccessful cases, they corresponded to products whose performance was considered below or extremely below expectations.

For data collection, a questionnaire was employed, which by means of 64 close-ended questions recuperated information about managing and handling of product development that gave rise to successful or unsuccessful product.

In the third phase, statistical techniques were applied to data collect. Initially, the association of the variables investigated was measure with the result of the product project (successful and unsuccessful) through the respective contingency coefficients. Hence, it was sought to determine which variables considered isolated, explained the success or failure of the new product. Also, reducing and summarizing the individuals variables was tried by using factorial analysis among factors was carried out.

The interpretation of the generated results from statistical procedures enabled finding a set of factors that affect the success of product development in the TBC, thus indicating priorities and information focus in PDP management.

4. Analysis of Results

The results in table 2 show correlation coefficients and their respective levels of significance (p) among ten main components (critical factors) and the result of new product for the companies of medical-hospital equipments (MHE), as well as for the companies of process control automation (PCA). In agreement with the methodology, each main component corresponds to a set of isolated variables, which by applying the multivariate analysis technique were reduced, aiming at facilitating data interpretation. Table 3 demonstrates the isolated variables considered equally significant for both sectors.

Table 2: Correlation between main components and the result of new product

Main Components	***Correlation Coefficient and Significance Level among the Main Components and the Result of the New Product***	
	PCA	**MHE**
Innovation degree	0,5382 (p=0,000)*	0,441 (p=0,002)**
Characteristics of market - target	0,3908 (p=0,003)**	0,592 (p=0,000)*
Product characteristics	0,4474 (p=0,001)*	0,449 (p=0,001)*
Technology sources	0,0983 (p=0,475)α	0,055 (p=0,709)α
Company competence	0,2011 (p=0,141) α	0,143 (p=0,328) α
Competency of project leader	0,4088 (p=0,002)**	0,489 (p=0,000) α
Integration	0,3061 (p=0,023)**	0,530 (p=0,000)*
Organization	0,1622 (p=0,237) α	0,097 (p=0,503)*
Execution quality of PDP	0,3988 (p=0,003)**	0,612 (p=0,000)*
Execution quality of others activities	0,1654 (p=0,227) α	0,424 (p=0,002)**

* Significant at p≤0,001 **Significant at p≤0,05 α Not significant at p≥ 0,10

Table 3: Association between isolated variables and the result of new product

Isolated Variables	***Contingency Coefficients and Significance Level Between Isolated Variables and Results of New Product***	
	PCA	**MHE**
Characteristics of market target		
Potential of well executed market	0.432 p=(0.015)**	0.426 p=(0.034)**
Interpretation of needs	0.478 p=(0.03)**	0.567 p=(0.000)*
Product characteristics		
Superior technical performance against competitors	0.509 p=(0.001)*	0.483 p=(0.006)**
Competency of project leader		
Interpersonal skills necessary for the project	0.447 p=(0.008)	0.394 p=(0.029)**
Managing skills necessary for the project	0.432 p=(0.013)	0.487 p=(0.004)**
Team participation in decision-making	0.419 p=(0.20)	0.423 p= (0.014)**
Quality of PDP activities		
Generating and selecting ideas	0.384 p=(0.023)**	0.513 p=(0.001)*
Analyzing viabilities (technical and economical)	0.479 p= (0.003)**	0.437 p=(0.021)**
Technical development (product project)	0.406 p=(0.014)**	0.458 p=(0.005)**
Preparing documents – homologizing product	0.502 p=(0.024)**	0.486 p=(0.042)**

* Significant at p≤0,001 **Significant at p≤0,05

The results suggest that the sectors emphasize different aspects in their PDP managing systems to generate the success of new product. It can be concluded the PCA companies are more product oriented, while the MHE companies are more process oriented.

The PCA companies are more concerned with product characteristics and the innovation degree that is incorporated. For this reason, they should give priority and much attention in structuring the technical and economic requisites of the product that will be developed (detail stage of product project and fabrication process), depending on the characteristics of the project leaders during this process. For the MHE companies, these components also were found to be relevant, however with moderate degrees of correlation.

Success in MHE is more dependent on the organization characteristics of the company, such as proficiency in carrying out PDP activities and marketing skills of the company. The successful projects are those in which marketing evaluation were carried out well and user requisites were well interpreted concerning new product specifications. Thus, it's important that such companies place more concern in the proficiency of PDP activities, above all, those related to pre-development (generating ideas, selecting ideas, formulating concepts and analyzing viability), because they were pointed out as being critical for success. These results were compatible with studies performed in many countries [12].

The values of main components referent to market-target and quality of PDP activities in the PCA sector of the companies present a reasonable correlation with the result factor of the new product (table 2). In the first component, besides the variables showed in table 3, the need for synergy between the new product and already explored markets by the companies could also be indicated as critical success factor. From the isolated variables that form the quality component of PDP activities, it can be verified that pre-development and project are factors that should be carefully managed in PDP activities by such companies.

The results in table 3 regarding preparation and follow-up of documents and reports necessary to homologize the product were considered equally significant by the companies of both sectors. While for the PCA companies, the quality need of this stage is connected to pressure by clients, in MHE companies it is due to legal norms imposed on the product.

It is presumed that in small companies, integration in the functional areas occurs naturally and freely, since proximity of individuals emphasizes the level of contact, facilitates communication and information exchange during PDP. Integration is substantially correlated to the result of new product in MHE companies; however, the same is not true for the other sector. The integration need in this sector was verified as being decisive during the execution of pre-development activities, which strengthens the results previously described.

According to [3], the project leader plays an important role in handling the development process of a new product, since he is directly responsible for organizing and directing the team members of development. Besides leading the team, he must know how to negotiated with the directory in order to obtain the necessary resources for the project. In order to perform this role, the leader must be endowed of managerial qualification and relationship skills to create and environment of trust, coordination and control.

Considered that the results of tables 2 and 3, corroborate [3] affirmations, reinforcing the importance of a leader that has technical and managing competencies related to project activities in order to develop a new product.

Three main components (skill levels of the company, technology sources and types of organizations structures applied to the development projects) contribute little or not at all in the success of the products developed by such companies.

Regarding levels of competency, two hypotheses can be viewed as an explanation of these results. The first one would be a more compliant judgment of the responders, in which they not directly hold the functional areas accountable for the eventual problems and mistakes that occurred in the unsuccessful projects. Another hypothesis suggests that successful projects as well as unsuccessful ones relied on appropriated effort and application by the individuals of the departments involved. In this case, the failure could be explained by another reasons and not the lack of technical competence.

The TBCs have a basic characteristic of developing high technology products and in the cases of successful products as well as unsuccessful ones; they predominately employ informal and internal company mechanisms for technological developments applied to the products they produce. That is the reason why technology achievement sources do not appear to be correlated to the result of new product.

Owing to the fact that small and mid-sized companies were research, that is, productive and informal companies in terms of organizational structure, the models of functional or matrix organization practically did not influence the success and failure of the products developed; since satisfactory level of communication and collaboration between the areas are facilitated by the characteristics of small-sized companies.

5. Conclusions

This paper analyzed management practices and critical success factors during the realization of new product development projects. Product development is a complex process and any research in this area shows limitations. The main restriction of this paper is related to the option made to examine critical success factors in the new product development projects, although just within specifics sectors of the Brazilian small and medium size TBCs. Future research may lead to investigate the core subject within other sectors, software and biotechnology, for example. Despite the limitations, some considerations can be made in view of the results obtained.

By interpreting the results obtained, it can be understood that such companies assign priority and be concerned with the characteristics of the products and their articulation with the company strategy. By so doing, they should pay much attention to the pre-development stage, when technical and economic requisites of the products to be developed are being structured (detail stage of the product project and manufacture process), and keep this in mind and attitude so that future products have a characteristic that pursues convergence with strategy and the company's target market.

The pre-development stage tends to be effective when right decisions are made to properly articulate product project and company strategies, capture desired technology and market information, and to analyze in early stages cost and prices of the product to be produced. Good decision making in this phase can be facilitated by creating a "multifunctional development team" right at the beginning of PDP steps, as suggested by [10].

Thus, from the PDP beginning, analyses and screenings within the areas of Production, Engineering, R&D (develops technology to be incorporated into the product) and Marketing, will be intensified and concentrated on the product to be developed. That integration can be deemed as an important management mechanism, since the multifunctional team boosts the accumulated knowledge exchange, by and amongst each company's function. Integration also diminishes uncertainties and consequently increases decisions quality as made during the beginning of the development; this is likely to lower project cost due to the probable reduction of problems occurrence throughout the PDP.

That type of organizational arrangements for product developments can be implemented more easily in small and medium companies, as those object of this research; due to their size, integration and inter-functional communication, the organizational arrangement tends to occur more naturally. It is a management mechanism to be better explored by the small and medium size TBCs in the PCA and MHE sectors.

Some results are not compatible with success factors in the literature concerning critical success factors in PDP. Since they are TBCs, there were expectations that the process of acquisition and technology transference were critical for such companies. However this hypothesis was not verified thought the results of this research. Lastly, it is hoped that the results of this work are able be added to the theoretical body concerning success factors in specific management environments of product development, and at the same time, contribute for improvements in PDP indicators when evidencing practices that condition the success or failure of new product.

6. References

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