Int. J. Production Economics 115 (2008) 559–568

Contents lists available at ScienceDirect

Int. J. Production Economics

journal homepage: www.elsevier.com/locate/ijpe

The influence of time-to-market and target costing in the new product development success

Paulo Afonso, Manuel Nunes *, António Paisana, Ana Braga

Department of Production and Systems Engineering, University of Minho, 4800-058 Guimarães, Portugal

ARTICLE INFO

Article history:
Received 29 January 2008
Accepted 11 July 2008
Available online 26 July 2008

Keywords:
Target costing
New product development
Cost management
Survey

ABSTRACT

This article uses recent research in new product development and target costing in order to test the relationship between the use of new product development firm practice and the product's development time and cost. Data were obtained from Portuguese manufacturing firms through a survey. In this study it was found that target costing and reduction of time-to-market together provide considerable advantages to users of these practices. Such companies can achieve reductions in new product development cycle time and cost without compromising quality and functionality. This paper offers a contribution to current literature by adding empirical evidence on the role of target costing in the process of new product development.

© 2008 Elsevier B.V. All rights reserved.

1. Introduction

One emerging area of research in the literature is the impact of internal firm variables/organizational variables on the ability of firms to minimize the time and cost of new product development (NPD). As manufacturing innovations spread throughout leading organizations, product development becomes a more important source of competitive advantage. The reduction of NPD cycle time may create relative advantages in market share, profit, and long-term competitiveness (Cooper and Kleinschmidt, 1995; Ittner and Larcker, 1997; Griffin, 1997). However, a competitive product must also address factors such as cost, performance, schedule and quality (Lynn et al., 1999).

Moving cost-management efforts from the production phase to the product development stage implies larger profits because cost reduction advantages accrue from the first unit. Furthermore, managing costs during the development stage is usually easier and cheaper than after the product is introduced (Ulrich and Eppinger, 2000). Thus, managing costs during product development emerges as an important step to increase the profitability of future products. In fact, using a multiple case study based on 10 German companies that adopted target costing (TC) practices, Horvath and Tani (1997) found that companies benefited from using cost-reduction practices and that cost reduction was perceived as the most important goal. This goal was followed by market-oriented product development, lead-time reduction for product development (time-to-market (TtM)), and high quality.

TC was developed by Toyota in the beginning of the 1960s and it has been used since that period by the Japanese automotive industry in general (Kato, 1993; Carr and Ng, 1995). TC or *genka kikaku* is a three-stage process (Cooper and Yoshikawa, 1994). Firstly, the target price is identified; secondly, a target margin is assumed; and thirdly, the target cost is calculated by subtracting its target margin from its target price (Cooper and Slagmulder, 1997). Value engineering (VE) and functional cost analysis (FCA) are used in order to eliminate excess of the current manufacturing cost over the allowable cost (Yoshikawa et al., 1994, 1995).

This article follows recent research in NPD and TC to test factors and variables that are associated with the NPD time and cost minimization abilities. Everaert and

* Corresponding author. Tel.: +351 253510344; fax: +351 253510343.
E-mail addresses: psafonso@dps.uminho.pt (P. Afonso), lnunes@dps.uminho.pt (M. Nunes), apaisana@dps.uminho.pt (A. Paisana), acb@dps.uminho.pt (A. Braga).

0925-5273/$ - see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.ijpe.2008.07.003

Bruggeman (2002) investigated the impact of using cost targets during NPD, in terms of design quality, product cost, and development time. Sánchez and Pérez (2003) analysed the relationship between the use of some practices at the level of the firm on the ability to reduce NPD time and cost in the Spanish Automotive Industry. On the other hand, Davila and Wouters (2004) identified alternative practices to TC during product development projects.

Drawing upon empirical evidence relating to the use of these practices in Portuguese manufacturing SMEs, this work tests the relationship between the use of NPD and the product's development time and cost. Data were obtained from Portuguese manufacturing firms through a survey. The questionnaire was designed to illustrate the role of TC and TtM within NPD in such firms.

This paper is structured as follows. Section 2 presents the literature review on NPD, TtM, and TC. Section 3 explains the research methodology used and the results of the survey are shown and discussed in Section 4. Section 5 highlights the main conclusions achieved in this research and presents opportunities for further research on this topic.

2. Literature review

The concepts of NPD, TtM and TC are of major importance in this work. The survey instrument was designed after an extensive literature review of published work in each of these areas. This section presents the main issues related to these concepts.

2.1. New product development

Proficiency in NPD can contribute to the success of many companies. According to Poolton and Barclay (1998), "if companies can improve their effectiveness at launching new products, they can double their bottom line. It is one of the areas left with the greatest potential for improvements." Many studies have focused on critical success factors (CSFs) associated with the success or failure of NPD. A selection of such research studies was reviewed.

Lynn et al. (1999) developed a model of the determinants of NPD success. They sent informants a series of cases and asked them to identify the key factors. Lester's (1998) study identified a range of potential problems that can derail well-intentioned NPD efforts. By working through these problems, Lester discovered the CSFs in five areas of NPD. Poolton and Barclay (1998) identified a set of six variables that have consistently been identified in the literature as being associated with successful NPD. Cooper and Kleinschmidt (1995) studied hundreds of cases to identify what makes the difference between winners and losers in the process of NPD. They extracted 12 common denominators of successful new product projects and seven possible reasons (blockers) to explain why success factors are invisible and why projects seem to go wrong or are otherwise not well executed.

The factors proposed by these four studies are not exactly the same, and it is in fact difficult to generate a common set of CSFs for NPD. It is even harder to generate these factors for any specific industry. There are many other studies on CSFs or drivers for NPD (e.g. Cooper and Kleinschmidt, 1995; Spivey et al., 1997; Montoya-Weiss and Calantone, 1994) reviewed 47 research studies on the determinants of new product performance and found that each of these studies attempted to identify the factors that improve NPD success rates. However, each used a somewhat different method, produced different factors, and reached results that are useful but sometimes inconsistent, or even contradictory with other studies' results. What they do share, however, is a general focus on what is necessary for successful NPD, namely: (1) top management support for innovation; (2) R&D, marketing and manufacturing competence and coordination; (3) involvement of suppliers and customers in the design process; (4) product quality; (5) nature of market; and (6) development time. It is not clear, though, whether the factors identified by previous research can be applied to SMEs due to their particular unique characteristics.

Another difference is the level (or unit) of study. Most of the studies were undertaken at the company level and asked questions that can be answered by general managers. However, many practical issues occur at the operational and functional level.

In this context, NPD speed is critical because product life cycles are shrinking and obsolescence is occurring quicker than in the past, whilst competition has also intensified (Sherman et al., 2000). To grow, it has become imperative for firms to move products to market faster (Vesey, 1992; Griffin, 2002). Firms that succeed in developing and marketing new products faster than competitors can obtain first mover advantages (Griffin, 2002). They may command higher prices, and then attain dominant market share and customer loyalty. Significant cost benefits can also accrue from compressing NPD cycle time (Gupta et al., 1992). Not surprisingly, the interest in accelerating the NPD has remained steadfast for its strategic importance (Gonzáles and Palacios, 2002).

2.2. Time-to-market

In global and highly competitive markets, products have reduced life cycles. This means that there is a need for companies to reduce the TtM of new products and simultaneously ensure their success in the market. Early product introduction improves profitability by extending a product's sales life and allowing development and manufacturing cost advantages. Faster product development leads to superior performance according to some empirical studies (Griffin, 1997; Ittner and Larcker, 1997).

The importance of TtM of new products as a factor of competitive advantage is well known. In fact, a considerable number of articles on this subject have been published in the last decade. Griffin (1997, 2002) used TtM as a dependent variable and analysed its relationship with the use of multifunctional teams, the use of formal processes of NPD and the degree of product complexity and originality. Thus, multifunctional teams were found to be associated with the biggest reductions in the development cycle of new products which have the highest degree of originality, whilst formal processes were associated with the biggest reductions in the development cycle of new more complex products.

On the other hand, Lambert and Slater (1999), Langerak et al. (1999), Sherman et al. (2000) refer that TtM is significantly related to (a) the number of suppliers used in the process, (b) the number of organizational functions that were integrated in the team involved in the development of new products, (c) the level of support and involvement of top management people, (d) the simultaneity of activities during the development process and (e) the definition of TtM as the firm's objective.

It is also important to point out the study by Ittner and Larcker (1997) who built a model that shows the existence of a significant dependency between certain organizational practices and TtM of new products.

Furthermore, Swink's (2003) study showed that higher product complexity leads to a longer TtM and that a higher involvement of top management in the development process implies a lower TtM.

2.3. *Target costing*

TC must be viewed as a broader concept that includes TC as well as other techniques inspired in Japanese cost-management practices such as Kaizen cost management and FCA (Yoshikawa et al., 1995).

Tani et al. (1994) argued that TC can be part of a wider concept of product cost management, called target cost management. In fact, Kato (1993) argued that TC should be used in a more "strategic" perspective and Carr and Ng (1995) presented Nissan's "total cost control concept", which is clearly a TC approach. These are different names for similar techniques which can be viewed as part of the same general approach.

Rabino (2001, p. 76) stated that in TC systems "Costs [which] are managed in three distinct ways [...]. Firstly, the mix of products that are manufactured and sold is strictly controlled by upper level management through the efforts of a multi-disciplinary team. Secondly, the costs of new products are reduced through the techniques of target costing and value engineering [which implies FCA]. Finally, the costs of existing products are reduced through the Kaizen system."

Finally, it should be highlighted that these techniques associated with TC are examples of the Japanese concept of continuous improvement. TC means continuous improvement in product development and design processes and Kaizen, which follows TC procedures, means cost reductions in the manufacturing and delivery processes (McMann and Nanni, 1995; Lee and Monden, 1996).

TC is a technique for managing product costs during the design stage (Kato, 1993; Ewert and Ernst, 1999). After setting the target costs, several coordination techniques can be used to manage tradeoffs between goals in the design of products and their costs, such as VE, FCA, cost tables and design for manufacture and assembly (Cooper and Slagmulder, 1999).

VE is used to determine allowable costs for each component in every major function of the product and to produce a cost-reduction objective for each component. FCA is well explained in Yoshikawa et al. (1994, 1995). These authors discussed the connection between FCA and VE as well as their applications. FCA is one of the most important techniques in target cost management because it is used to help product designers to find feasible technical solutions that fit the target cost—"functional cost analysis ... [is] ... a powerful technique to cost management." (Yoshikawa et al., 1994, p. 63). FCA uses cost tables to identify product costs according to their specifications because different product requirements imply different process times and changes in components. Cost tables are usually updated every year or twice a year (Tani et al., 1994) and they represent the firm's cost experience because "... cover a wide range of design possibilities and include cost information both internal and external to the organization."—Yoshikawa et al. (1995, p. 417). Cost tables include "cost elements" such as material costs, purchased parts, direct processing costs and overhead. Cost tables are particularly relevant for companies that have a considerable number of different products, different models and a large range of product's options. In fact, Carr and Ng (1995) point out that for cases where the diversity is not so high, cost tables may not be so useful and their update not so relevant.

These techniques are applied in several iterations in order to achieve the predefined allowable cost. Furthermore, Kaizen cost management involves several procedures that allow reducing costs via continuous improvements during the production phase of the product life cycle. Kaizen asks for the involvement of everyone. Imai introduced the term Kaizen in the 1980s, defining it as an ongoing improvement involving everyone from top management to operators.

Tani et al. (1994) found a wide application of TC in the 1990s in several process industries but particularly in the assembling industry. According to some authors, more than 80% of the major companies in assembly-type industries have already adopted TC practices (Kato, 1993; Carr and Ng, 1995). These practices are being applied in industries characterized by high levels of competition which demands continuous reductions of costs maintaining products' standards of quality. For example, TC practices can be valuable for firms that operate in markets characterized by high value-added products because such products are associated with sophisticated customers who distinguish and value differences in the quality of products.

In brief, it can be argued that the literature review undertaken suggests that the reduction of TtM and the use of TC contribute to NPD success. Consequently, the following hypothesis can be formulated: the reduction of TtM and the use of TC positively influence the success of NPD.

3. Research methodology

An electronic questionnaire was designed to gather information about the impact of TC in NPD in Portuguese manufacturing SMEs. Survey method is often used because it is time and cost efficient and it permits statistical analysis. The replication of the questions is possible, allowing results and patterns to be compared and analysed. Multiple questions were used to enhance construct validity (Foster and Swenson, 1997).

Prior to the implementation of the survey, it was necessary (i) to design the structure of the questionnaire, including the electronic version, (ii) to collect SMEs contacts and (iii) to test the web gathering data system. Contacts were obtained mainly from a database comprising the biggest 1500 Portuguese SMEs in the years 2005 and 2006. Only manufacturing SMEs were considered in the sample. An email was sent to 500 manufacturing SMEs containing a short message that explained briefly the purpose of the project and its relevancy. A link to the electronic questionnaire was also attached. One and 2 weeks after the initial contact, a first and a second reminder were sent by email.

The design of the questionnaire began by identifying core concepts in the literature. Most of the questions were built according to previous research work undertaken by other authors (e.g. Ittner and Larcker, 1997; Griffin, 1997).

NPD and TC were defined as a set of different techniques and practices. The use and extent in which NPD and TC are applied was assessed through several simple statements. Dekker and Smidt (2003) followed a similar approach to analyse the use of TC in Dutch firms. These authors stated that TC has been developed and applied independently of the Japanese practice. Thus, it can be argued that in manufacturing SMEs, TC may be interpreted in different ways and named differently. Indeed, 60% of the firms surveyed by Dekker and Smidt (2003) used techniques comparable to TC but only one company recognised the concept of "target costing". The statements presented in the current survey were revised several times in order to reduce wording and to make them more accessible to respondents.

The questionnaire was designed in order to highlight the way in which NPD has been undertaken in Portuguese companies and the extent of the use of TC techniques. The majority of the questions were measured using a five-point Likert scale. Likert scales were particularly useful to measure the level of use of each technique.

The electronic questionnaire was presented through seven different windows (the questionnaire is presented in Appendix A). Firstly, general information about the firm was asked by using six questions (e.g. number of workers, industry). Secondly, three questions were designed in order to characterize the NPD process in the company. The third window includes three questions related to TtM. The fourth panel of questions aimed at measuring—on a five-point Likert scale—the success level of NPD initiatives by using the following seven measurements: new product success rate, percentage of sales from products less than 3 years old, new product launching frequency, customer satisfaction degree, market share, new product quality level and unitary cost of products (Ittner and Larcker, 1997; Griffin, 1997). The fifth and sixth windows assessed the extent of the use of TC practices. The use of TC was measured on a five-point Likert scale through seven statements. It comprises the following techniques: TC, attribute costing, Kaizen cost management, FCA, the quality–functionality–price paradigm and confrontation strategy (Yoshikawa et al., 1994; Cooper and Yoshikawa, 1994; Carr and Ng, 1995, p. 351; Yoshikawa et al., 1995, p. 415, 423; Guilding et al., 2000, pp. 131–133; Cooper and Slagmulder, 2004).

At the end of the questionnaire a space for comments was provided. A technical text on this topic was also offered to all of them who concluded the questionnaire. Additionally, respondents were able to give an email address in order to receive a report with the main results of the survey.

Because of the large number of variables, the survey's data were partially reduced to a limited number of factors through factor analysis. This data reduction method is used to identify underlying variables, or factors, that explain the pattern of correlations within a set of observed variables. For a recent example on the use of factor analysis see Pizzini (2006). To perform the extraction of the factors the method of the principal components analysis was used. Furthermore, the meaning of the extracted factors was enhanced through the "varimax" method. Varimax is an orthogonal rotation method that minimizes the number of variables with high coefficients or loadings on each factor, thus simplifying the interpretation of the results. In general, coefficients higher than 0.5 are considered significant. The necessary number of the main components needed to describe the data was obtained through the criterion of Kaiser–Meyer–Olkin (KMO). KMO is a statistics which measures sampling adequacy and it is used to check the quality of the correlations amongst the variables. In this case, all the extracted factors have eigenvalues higher than one. Values of KMO close to 1 indicate that the factor analysis is significant: very good if higher than 0.9 and good for values between 0.8 and 0.9, whilst for values lower than 0.5 the factor analysis is not significant, because there is no strong correlation amongst the variables.

Subsequent to the KMO test, the fidelity of the new variables (factors) was tested by analysing the Cronbach's α (alpha). Cronbach's (1951) α is one of the most used measures for the verification of internal consistency within a group of items (e.g. Cagwin and Bouwman, 2002). The correlations amongst the variables and the extracted factors were also analysed. The achieved correlation measures reveal how variables are related. As a rule of thumb, it is assumed that a coefficient value higher than 0.7 reveals an internal consistency between the reasonable and the very good, and for values higher than 0.9 the factor's internal consistency is very good.

Table 1
Factor analysis

Variables/extracted factors	Success index	Component-level TC	Product-level TC
Success factors:			
New product success rate	0.795		
Percentage sales from products <3 years old	0.798		
New product launching frequency	0.705		
Customer satisfaction degree	0.743		
Market share	0.796		
New product quality level	0.698		
Target costing:			
Target cost = market price–expected margin		−0.024	0.826
Functional cost analysis		0.718	0.207
Attribute costing		0.439	0.341
Inter-organis. cost manag. (buyers–suppliers)		0.841	0.147
Trade-off functionality–price		0.691	0.075
Quality–functionality–price paradigm		0.335	0.557
The perceived use of TC by the firm		0.244	0.709
KMO	0.841	0.708	
Eigenvalue	3.44	2.066	1.681
Percent of variance	57	30	24
Cronbach's α	0.845	0.731	

Extraction method: principal component analysis.
Rotation method: varimax with Kaiser normalization.
Source: rotated component matrix (a); a. Rotation converged in three iterations.

4. Results and discussion

A total of 97 responses were received, representing a response rate of 19.4%. However, these comprised 15 answers from firms that were not involved in NPD activities. Thus, only 82 responses were analysed. Factor analysis was used to compose the expected latent variables "NPD success" and "TC". TtM was analysed through one of the observed variables (window3: TtM–b).[1] The main results are presented in Table 1 (variables follow the same order as they are presented in the questionnaire).

Factor analysis grouped the different measures of success into a single factor (KMO and Cronbach's α equal to 0.841 and 0.845, respectively). However, the analysis of the use of TC techniques produced two different factors (KMO and Cronbach's α equal to 0.708 and 0.731, respectively). Considering the variables which compose each extracted factor, Factor 1 was named "component-level TC" and Factor 2 "product-level TC" (Cooper and Slagmulder, 1999). The latter is focused on the product designers' ability to design and redesign products which are market-driven in terms of price and specifications. On the other hand, "component-level TC" involves suppliers and buyers in a subsequent and iterative effort to reduce the costs of the product. Dekker and Smidt (2003) also referred that TC involves several procedures at these two different levels.

[1] "Comparing with the industry (and particularly with your competitors) the design and development time for new products is: …". Measured between much more lengthy and much faster.

For each factor analysis additional statistics such as correlation matrix of variables, initial solution (e.g. communalities) and rotated component matrix were produced. The relevant computed factors were saved as variables for further analysis. The selected method for calculating the scores of the factors was the regression method.

Furthermore, the correlations between the extracted factors were also analysed. To compute correlation coefficients the Pearson's correlation coefficient was used. Correlation coefficients range in value from −1 to +1, meaning that there is a perfect negative or positive, respectively. A value of 0 indicates no linear relationship. The significance of the correlation coefficients was tested through two-tailed probabilities. In this case, a few but very important significant correlations were effectively achieved, namely TtM–NPD Success, and Product level TC–NPD Success. Only the significant correlations are shown in Table 2.

When these results are taken into account, it could be expected that NPD is positively influenced by TC and TtM. To test this, a multiple linear regression model of the type presented below was computed:

$$\hat{y} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 \quad (1)$$

where $\hat{y}$ is an estimate of NPD success, b_0, b_1, b_2 and b_3 are the coefficients estimates to constant, and for the three independent variables (TC component level, TC product level and TtM). The results of the multiple regression hypothesis test are shown in Table 3.

Table 3 indicates that the TC component level is not statistically significant to NPD success ($t = 1.137$, $p = 0.259$). Thus, the same model was computed using the stepwise method to select the relevant variables. The results obtained are shown in Table 4.

Table 2
Correlation coefficients

		Success index	Component-level TC	Product-level TC
Time-to-market	Pearson correlation	**0.530**(*)	0.129	0.172
	Sig. (2-tailed)	0.000	0.248	0.123
Success index	Pearson correlation	1	0.168	**0.302**(*)
	Sig. (2-tailed)		0.133	0.006

*Correlation is significant at the 0.01 level (2-tailed).

Table 3
Results of multiple regression hypothesis test: NPD success

	Coefficients		t	p Value	95% Confidence interval for B	
	B	Std. error			Lower bound	Upper bound
(Constant)	−1.887	0.383	−4.928	0.000	−2.650	−1.125
TtM (time-to-market)	0.586	0.116	5.075	0.000	0.356	0.816
Component-level TC	0.106	0.093	1.137	0.259	−0.079	0.291
Product-level TC	0.219	0.094	2.345	0.022	0.033	0.406

Adjusted $R^2 = 0.338$, $F_{3,78} = 13.259$, $p < 0.001$.

Table 4
Results of multiple regression hypothesis test using stepwise selection: NPD success

	Coefficients		t	p Value	95% Confidence interval for B	
	B	Std. error			Lower bound	Upper bound
(Constant)	−1.943	0.381	−5.105	0.000	−2.700	−1.185
TtM (time-to-market)	0.603	0.115	5.260	0.000	0.375	0.832
Product-level TC	0.217	0.094	2.315	0.023	0.030	0.403

Adjusted $R^2 = 0.327$, $F_{2,79} = 19.171$, $p < 0.001$.

Table 4 indicates that the TC product level is statistically significant to NPD success ($t = 2.315$, $p < 0.05$) as well as to TtM ($t = 5.260$, $p < 0.05$). This table also illustrates that TtM and TC product level have a positive impact on NPD success. Overall, the model explains 32.7% of the variance in NPD success analysis and is significant at $p < 0.001$.[2]

Fig. 1 presents the main results attained. These results suggested that

- As other researchers have indicated (e.g. Everaert and Bruggeman, 2002; Sánchez and Pérez, 2003), both TtM and TC are relevant for the success of NPD processes.
- “TtM” is highly correlated with the success index. Furthermore, TC (product level) is also correlated with the success of NPD.
- TC practices are represented by a set of techniques that were not included into a single factor. The existence of two different factors suggests different levels of application of TC in SMEs. Furthermore, the two factors extracted from the set of TC techniques are not equally correlated with successful NPD processes.
- There is a positive relationship between the use of TC and reduced TtM. However, it does not represent a significant correlation.

The discussion and implications of the empirical results obtained in the regression analysis are presented in the next subsections.

4.1. Both TtM and TC are relevant for NPD success

This study analysed the relationship between the use of NPD firm practice and the product’s development time and cost. In order to consider so many variables, a multidimensional success index was used (the reliability of the success index measured via Cronbach’s α was 0.845). This index was built from six measurements (all of them were measured at the firm level of analysis): new product success rate, percentage of sales from products less than three years old, new product launching

[2] To examine whether the assumptions of regression analysis had been contravened, tests were conducted to assess the homogeneity of variance of residuals (plots of residuals vs predicted values are due) and to prove the normality of the residuals with mean zero the test of Kolmogorv–Smirnov with correction to Lilliefors test ($p > 0.05$) was performed as well a probability plot of the residuals.

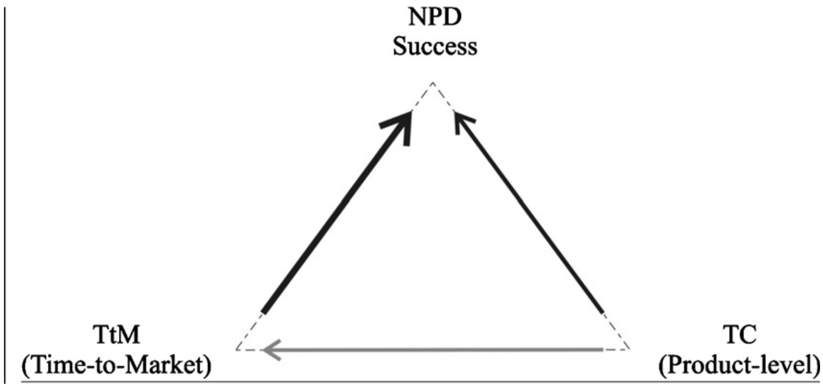

Fig. 1. Determinants of NPD success.

frequency, customer satisfaction degree, market share and new product quality level.

One of the main objectives of this research work was to analyse whether there is a direct relationship between TtM and the success of new products. The value of the correlation between the multidimensional success index and TtM of new products in this study equals 0.530 (Pearson's correlation coefficient, statistically significant for $\alpha = 5\%$). Therefore there is a direct relationship between these two variables. This means that the greater the reduction in the time taken to develop a new product, the greater the probability of its success in the market. Although a number of researchers have proposed a relationship between cycle time and success (Ittner and Larcker, 1997; LaBahn et al., 1997), few have found empirical evidence to support this assumption (Lynn et al., 1999). This research adds empirical evidence of the relationship between TtM and NPD success. This finding is of major importance because it highlights how important can be the different management practices which have a positive contribution to reduce the product's development time.

Furthermore, the ability to design cost-effective and cost-competitive products is also related to NPD success. In fact, TC represents a valuable tool to guide the development of new products enhancing their success when introduced in the market. Results showed a significant correlation (Pearson's correlation coefficient equals 0.302) between the use of TC and the success index. This finding appears to confirm Cooper and Slagmulder's (1999) arguments, which emphasize that TC is a strategic weapon to ensure that products are suitably introduced in the market. TC allows companies to design products that are simultaneously competitive in price and profitable. TC guides and disciplines the development of new products and augments the probability of success when they are launched. TC allows designing competitive products in price, quality and functionality. These three elements comprise the "survival triplet" (Cooper, 1996). A correct balance between these permits the introduction of new products which are in the "survival zone". Furthermore, the use of TC represents a strong commitment that results in continuous and permanent efforts on cost control and cost-reduction initiatives.

However, the application of TC can be viewed from two different perspectives which represent different implications in terms of NPD success.

4.2. *TC: product and component levels*

The use of some TC techniques is not correlated with NPD success. There are two extracted factors (Cronbach's α was 0.731) related to TC which were named "product-level" and "component-level" TC (Cooper and Slagmulder, 1999). Results suggest that some of the firms surveyed used TC to optimize production and technical features (components) and others to design competitive products in terms of quality and price but not both.

Firms that apply TC techniques without a "market perspective" are those which supply large firms. In these cases, suppliers use component-level TC in order to respond to clients' downward pressures. In this context, TC is mainly used to deal with several feedbacks from the client in very iterative processes which characterize complex new products with a high level of complexity. In general, suppliers are not able to manage products' quality (presented as production requirements) and focus their efforts on functionality and price. The design of complex products asks for the redesign of parts or products and many times for the inclusion of new or modified functionalities.

On the other hand, some manufacturing SMEs apply TC techniques from a much more "market perspective". These companies have a focus on quality–price instead of functionality–price and do not develop so much complex products. Simpler products do not ask for constant redesign and intensive supplier–buyer activities. These companies have a closer connection with the market and probably design new products which are sold directly to the customer. Thus, survey's respondents (manufacturing SMEs) are not able to apply TC in very complex products simply because they do not produce such products. SMEs which are included in complex NPD processes are mainly suppliers of large and international supply chains.

Results demonstrate that only the product-level TC is correlated with NPD success. This means that, in this context, the use of TC improves firm's results via the introduction of profitable new products. These companies apply TC because it contributes to the development of competitive new products. Product-level TC is related with the successful introduction of new products in the market and it is a relevant instrument for companies that develop such products. However, findings suggest that TC is particularly useful to improve NPD success when products are relatively less complex. In fact, in general, SMEs are not prepared to design very complex new products. Suppliers can be involved in the development of complex products which ask for the use of TC techniques from a "production perspective". However, in these cases, component-level TC is imposed by the client or the nature of the industry. The use of component-level TC is thus not an option made by the company itself.

4.3. *TC is not significantly correlated with time-to-market*

From the regression analysis performed, it can see that TC was not significantly related to the TtM of new products. According to Davila and Wouters (2004) this can happen because revenue drivers become much more relevant than product cost drivers. That is, because TC happens within the development process, the attention of product development managers shifts from TtM of new products to product costs. When TtM are key to profitability, product development managers have neither the time nor the attention span to identify alternatives, estimate their costs impact and choose the one that minimizes costs. The idea is not to find the best solution, but essentially to find one. Thus, results of this work give some support to Davila and Wouters's (2004) claims. According to these authors, there are alternative approaches to TC which can be used to manage costs and reduce TtM around the NPD process. In fact, results show a positive relationship between TtM and TC. However, and because this relationship is not significant, these results also suggest that reduced TtM can be found in environments where TC is not used. Equally, they permit to conclude that TC may be used in NPD processes not characterized by reduced TtM. Furthermore, these findings suggest that the reduction of TtM can be related to alternative cost-management techniques. Based on a field study, Davila and Wouters (2004) identified several alternative techniques to TC (e.g. modular design for cost, parallel cost-management teams). Furthermore, Cooper (1996) gives the example of Olympus to justify that the adoption of just-in-time and quality-management practices contributes to reduce TtM. These practices can reduce TtM in firms where TC is not applied. In Tani et al.'s (1994) and Horvath and Tani's (1997) surveys, "timely introduction of new products" is one of the most important objectives of TC. However, empirical evidence from this research proves that TtM may also be related with the use of other techniques and practices, both cost and non cost based.

5. Conclusions

In this study it was found that both TC and TtM are correlated to NPD success. Thus, TC and reduction of TtM together provide considerable advantages to users of these practices. Those companies which can manage both are able to achieve reduced NPD cycle time and cost without having to compromise on quality and functionality. As a result they will gain market share and experience economic success. The results obtained in this research are in line with Everaert and Bruggeman's (2002) work. These authors also found that target costs permitted the development of lower-cost new products without compromising quality and time. In fact, TC and product development literature has been suggesting that cost, quality and development time must be analysed together. Cooper and Kleinschmidt (1995) even agree that the combination of cost, quality and reduced TtM determine the success of new products. However, there is still little empirical evidence of such relationship in the literature.

However, TtM is not significantly correlated with TC, which means that TtM can be influenced also by other types of practices or techniques. This statement finds some support in Cooper (1996) and corroborates Davila and Wouters's (2004) claim for the relevancy of other non-TC techniques within NPD. In fact, this research offers empirical evidence on the importance of TC in NPD, but findings also suggest that success may depend on other techniques and practices that go beyond TC.

Results proved that TtM and TC are relevant to enhance NPD success but they also suggested that TtM and TC are much more complex phenomena than it has been presented in the literature. Companies can apply TC techniques from different perspectives, for different objectives and under different constraints. Dekker and Smidt (2003) stated that TC involves several procedures at two different levels. Initially, product designers are pushed to reduce product costs and afterward a "component-level TC" concept is passed on to suppliers. In this context, suppliers are expected to offer components that fit the established target price as well as the required quality and functionality. The results obtained in this research project have shown that the contribution of TC to NPD may differ according to whether it is applied by companies which are suppliers in a supply chain or they sell directly to the customer. The use of TC can be a distinctive strategic option or it can be simply an imposition from the buyer. In fact, in some cases, the use of specific TC techniques can be forced by the characteristics of the product or the nature of the industry and do not represent any competitive advantage. All these aspects deserve additional and further research.

Following previous survey-based research (e.g. Tani et al., 1994; Dekker and Smidt, 2003; Sánchez and Pérez, 2003), this paper contributes to the literature by adding empirical evidence on the role of TC within NPD. On the other hand, it complements previous contributions mainly based on anecdotes and case studies (e.g. Yoshikawa et al., 1994, 1995; Cooper, 1996; Cooper and Slagmulder, 1999; Ibusuki and Kaminski, 2007) and experiments (e.g. Everaert and Bruggeman, 2002). The article also poses additional questions to be developed in further research and it suggests managerial implications of TC and TtM in NPD.

Acknowledgements

Thanks are due to the two anonymous referees and the editor for their comments and contributions on earlier versions of this paper. The first-named author is too thankful to "Fundação para a Ciência e a Tecnologia" for their financial support.

Appendix A

Questionnaire

All respondents who were considered for analysis answered *yes* to the following initial question: "During the past five years, did your firm launch a new product or one significantly improved from the firm's perspective?"

Window 1: *General information*

(a) What is your main function in the firm?
(b) How many years have you been in the firm?
(c) Number of employees:
(d) Annual sales (approx. in millions euros):
(e) Company (main) location:
(f) Industry:

Window 2: *New Product Development*

(a) Please classify the degree of participation in the new product development process of:
  1. Marketing Department
  2. Production Department
  3. Engineers and Designers
  4. Suppliers
  5. Distributors
(b) Which of the following organizational approaches define better how your new product development process is supported from?
  1. A new product or R&D Department supported by permanent staff
  2. An autonomous group
  3. A product manager
  4. A new products manager
  5. A committee supervise all projects concerned with the development of new products
(c) Choose the option that defines better how the company manage the process of new products development:
  1. All projects are developed inside the company
  2. The majority of the projects are developed inside the company
  3. Fifty percent of the projects are developed inside the company
  4. The majority of the projects are developed outside the company
  5. All projects are developed outside the company

Responses on each item of question (a) are measured on a five-point Likert scale with "very low" and "very high" as endpoints. Questions (b) and (c) are single choice.

Window 3: *Time-to-market*

(a) During the last five years, the design and development time required for new products.
(1) Reduced a lot/ (2) Reduced/ (3) Kept at the same level/ (4) Increased/ (5) Increased a lot.
(b) Comparing with the industry (and particularly with your competitors) the design and development time for new products is:
(1) Much more lengthy/ (2) More lengthy/ (3) The same/ (4) Faster/ (5) Much faster
(c) Please, indicate the approximate time of design and development of a new product in your company.
Minimum:/Medium:/Maximum:

Window 4: *Success level of NPD*

(a) Comparing the performance of your new products with the results of your competitors:
  (1) The percentage of successful new products is…
  (2) The percentage of sales obtained from products launch in the last 3 years is…
  (3) The frequency of new products launch in the market is…
  (4) The level of clients' satisfaction with new products is…
  (5) The market share of new products is…
  (6) The quality of new products is…
  (7) The unitary cost of products is…

Responses on each item are measured on a five-point Likert scale: "very below the average"—"below the average"—"on the average"—"above the average"—"very above the average". *Source*: Ittner and Larcker (1997), Griffin (1997).

Windows 5 and 6: Cost Management

(a) Considering your company, please indicate the level of agreement with the following statements:
  1. For the development of new products, it is usual to compute the desirable production cost of the new product from the following formula: *"maximum allowable cost = potential market price–margin expected for this product"*.
  2. During the design process of a new product, they are made many changes in the product in order to not exceed a predetermined maximum production cost.

3. During the New Product Development process, product's attributes which are considered too costly when compared with the value attributed by the client are reduced/eliminated (e.g. package, warranties, after sales service, etc.).
4. The company usually negotiates with suppliers and clients changes on product design and/or its functionalities in order to be achieved a predetermined product cost.
5. During the New Product Development process, the company tries to add additional features or functionalities to the product if it is not possible to offer a lower price than competitors.
6. During the New Product Development process, the company aims to beat competitors designing competitive products in price, functionality and quality.
7. Comparing with competitors, this company has a higher level of use of target costing techniques in the New Product Development process.

Responses on each item are measured on a five-point Likert scale with "very low" and "very high" as endpoints. *Source*: Cooper and Yoshikawa (1994), Yoshikawa et al. (1994, 1995), Carr and Ng (1995), Guilding et al. (2000), Dekker and Smidt (2003), Cooper and Slagmulder (2004).

References

Cagwin, D., Bouwman, M., 2002. The association between activity-based costing and improvement in financial performance. Management Accounting Research 13 (1), 1–39.

Carr, C., Ng, J., 1995. Total cost control: Nissan and its UK supplier partnerships. Management Accounting Research 6 (4), 347–365.

Cooper, R., 1996. Costing techniques to support corporate strategy: Evidence from Japan. Management Accounting Research 7 (2), 219–246.

Cooper, R., Slagmulder, R., 1997. Target Costing and Value Engineering. Productivity Press, Portland, OR.

Cooper, R., Slagmulder, R., 1999. Develop profitable new products with target costing. Sloan Management Review 40 (4), 23–33.

Cooper, R., Slagmulder, R., 2004. Interorganizational cost management and relational context. Accounting, Organizations and Society 29 (1), 1–26.

Cooper, R., Yoshikawa, T., 1994. Interorganizational cost management systems—The case of Tokyo–Yokohama–Kamakura supplier chain. International Journal of Production Economics 37 (1), 51–62.

Cooper, R.G., Kleinschmidt, E.J., 1995. Benchmarking the firm's critical success factors in new project development. Journal of Product Innovation Management 12 (5), 374–391.

Cronbach, L., 1951. Coefficient alpha and the internal structure of tests. Psychometrika 16, 297–333.

Davila, A., Wouters, M., 2004. Designing cost-competitive technology products through cost management. Accounting Horizons 18 (1), 13–26.

Dekker, H., Smidt, P., 2003. A survey of the adoption and use of target costing in Dutch firms. International Journal of Production Economics 84 (3), 293–305.

Everaert, P., Bruggeman, W., 2002. Cost targets and time pressure during new product development. International Journal of Operations & Production Management 22 (12), 1339–1353.

Ewert, R., Ernst, C., 1999. Target costing, co-ordination and strategic cost management. The European Accounting Review 8 (1), 23–49.

Foster, G., Swenson, D., 1997. Measuring the success of activity-based cost management and its determinants. Journal of Management Accounting Research 9, 107–139.

Gonzáles, F., Palacios, T., 2002. The effect of new product development techniques on new product success in Spanish firms. Industrial Marketing Management 31 (3), 261–271.

Griffin, A., 1997. PDMA research on new product development practices: Updating trends and benchmarking best practices. Journal of Product Innovation Management 14 (6), 429–458.

Griffin, A., 2002. Product development cycle time for business-to-business products. Industrial Marketing Management 31 (4), 291–304.

Gupta, A.K., Brockhoff, K., Weisenfeld, U., 1992. Making trade-offs in the new product development process: A German/US comparison. Journal of Product Innovation Management 9 (1), 11–18.

Guilding, C., Cravens, K., Tayles, M., 2000. An international comparison of strategic management accounting practices. Management Accounting Research 11 (1), 113–135.

Horvath, P., Tani, T., 1997. Japanese–German comparison of target costing management. Paper Presented at the 1997 EAA Congress in Graz.

Ibusuki, U., Kaminski, P., 2007. Product development process with focus on value engineering and target-costing: A case study in an automotive company. International Journal of Production Economics 105 (2), 459–474.

Ittner, C.D., Larcker, D.F., 1997. Product development cycle time and organizational performance. Journal of Marketing Research 34 (1), 13–23.

Kato, Y., 1993. Target costing support systems: Lessons from leading Japanese companies. Management Accounting Research 4 (1), 33–47.

LaBahn, D.W., Ali, A., Krapfel, R., 1997. New product development cycle time: The influence of project and process factors in small manufacturing companies. Journal of Business Research 36 (2), 179–188.

Lambert, D., Slater, S.F., 1999. Perspective: First, fast, and on time: The path to success, or is it?—direct versus reverse regression. Journal of Product Innovation Management 16 (5), 427–438.

Langerak, F., Peelen, E., Nijssen, E., 1999. A laddering approach to the use of methods and techniques to reduce the cycle time of new-to-the firm products. Journal of Product Innovation Management 16 (2), 281–289.

Lee, J., Monden, Y., 1996. An international comparison of manufacturing-friendly cost management systems. The International Journal of Accounting 31 (2), 197–212.

Lester, D.H., 1998. Critical success factors for new product development. Research Technology Management 41 (1), 36–43.

Lynn, G.S., Abel, K.D., Valentine, W.S., Wright, R.C., 1999. Key factors in increasing speed to market and improving new product success rates. Industrial Marketing Management 28 (4), 319–326.

McMann, P., Nanni, J., 1995. Means versus ends: A review of the literature on Japanese management accounting. Management Accounting Research 6 (4), 313–346.

Montoya-Weiss, M.M., Calantone, R., 1994. Determinants of new product performance: A review and meta-analysis. Journal of Product Innovation Management 11 (5), 397–417.

Pizzini, M., 2006. The relation between cost-system design, managers evaluations of the relevancy and usefulness of cost data, and financial performance: An empirical study of US hospitals. Accounting, Organizations and Society 31 (2), 179–210.

Poolton, J., Barclay, I., 1998. New product development from past research to future application. Industrial Marketing Management 27 (3), 197–212.

Rabino, S., 2001. The accountant's contribution to product development teams—a case study. Journal of Engineering and Technology Management 18 (1), 73–90.

Sánchez, A.M., Pérez, M.P., 2003. Cooperation and the ability to minimize the time and cost of new product development within the Spanish automotive supplier industry. Journal of Product Innovation Management 20 (1), 57–69.

Sherman, J.D., Souder, W.E., Jenssen, S.A., 2000. Differential effects of the primary forms of cross functional integration on product development cycle time. Journal of Product Innovation Management 17 (4), 257–267.

Spivey, W., Munson, A., Michael, J., Wolcott, J.H., 1997. Improving the new product development process: A fractal paradigm for high-technology products. Journal of Product Innovation Management 14 (3), 203–218.

Swink, M., 2003. Completing projects on-time: How project acceleration affects new product development. Journal of Engineering and Technology Management 20 (4), 319–344.

Tani, T., Okano, H., Shimizu, N., Iwabuchi, Y., Fukuda, J., Cooray, S., 1994. Target cost management in Japanese companies: Current state of the art. Management Accounting Research 5 (1), 67–81.

Ulrich, K.T., Eppinger, S.D., 2000. Product Design and Development. Irwin/McGraw-Hill, Boston, MA.

Vesey, J.T., 1992. Time-to-market: Put speed in product development. Industrial Marketing Management 21 (2), 151–158.

Yoshikawa, T., Innes, J., Mitchell, F., 1994. Applying functional cost analysis in a manufacturing environment. International Journal of Production Economics 36 (1), 53–64.

Yoshikawa, T., Innes, J., Mitchell, F., 1995. A Japanese case study of functional cost analysis. Management Accounting Research 6 (4), 415–432.