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Industrial Marketing Management 33 (2004) 307–316

INDUSTRIAL MARKETING MANAGEMENT

Criteria employed for go/no-go decisions when developing successful highly innovative products

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Received 29 May 2002; received in revised form 1 May 2003; accepted 2 June 2003

Abstract

Based on a sample of 77 highly innovative products, this study examines the usage and the relative importance of a set of go/no-go decision criteria at four major gates of the new product development (NPD) process. The findings reveal that go/no-go criteria can be grouped into five dimensions: strategic fit, technical feasibility, customer acceptance, market opportunity, and financial performance. Strategic fit dimension is mainly applied in approving the new product concept. Technical feasibility dimension is crucial in approving the new product concept and the product prototype. The usage of customer acceptance dimension is notably high throughout the entire development process, particularly after product launch. Market opportunity dimension is mostly employed to approve the new product concept and the maintenance of the product on the market. Financial performance dimension stands out near the end of the development process.

Keywords: Go/no-go criteria; Review points; New product evaluation; Highly innovative products

1. Introduction

The essence of product innovation is to create or establish something new. Since this process necessarily involves risk, innovating firms require a strategy not of risk avoidance, but of early diagnosis and management (Keizer, Halman, & Song, 2002). Total risk avoidance is impossible unless a company decides to avoid innovation (Cooper, 2001).

One means for managing the risks of new products is introducing go/no-go decision points (i.e., review points or gates) throughout the new product development (NPD) process (Crawford, 1989; de Brentani, 1986; Kuczmarski, 1988; O'Connor, 1996). These points provide an assessment of the quality of the project, ensuring the firm does the right projects and does them correctly (Cooper, 2001; Martinsuo & Nissinen, 1998; Moore, 1982). Gates provide the quality-control mechanism in the process and support go/no-go and prioritization decisions (Cooper, 2001). Nowadays, most conceptualizations of the new product development incorporate those review points or gates (Cooper, 2001; Griffin, 1997).

An important component of the review points are the criteria employed in evaluating new products and making go/no-go and prioritization decisions. Both researchers and practitioners agree on the significance of having well-defined decision criteria. According to Hart, Hultink, Tzokas, and Commandeur (2003) and Kuczmarski (1988), it allows management to allocate responsibility and exercise control that reflects managerial fairness and justice. It also ensures an understanding of the intent and expectations of data that must be supplied (Englund & Graham, 1999) and increases the quality of communication among the parts involved in the process (Suomala & Jokioinen, 2001). Specifying the weighting or relative importance of each criterion is also crucial given that a change in weights can radically alter the decision (Jiang & Klein, 1999).

Literature on new product development has generally centered on NPD activities rather than on review decisions. As a result, there is limited knowledge of how managers evaluate projects and make critical go/no-go decisions throughout the entire development process (Schmidt & Calantone, 1998). According to Ronkainen (1985), "a major issue that has been overlooked is whether or not the

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doi:10.1016/S0019-8501(03)00080-4

same set of go/no-go criteria is used at each and every decision-making point or whether the weights of individual criteria vary from one point to another''. The present study attempts to advance understanding of this matter by analyzing the type of go/no-go criteria applied at several NPD review points. In addition, the study examines shifts in the usage and relative importance of five dimensions of criteria through the NPD process. Our findings are helpful for project selection and project evaluation purposes, particularly for weighting criteria.

An issue raised in the literature is that researchers should be precise in the definition of the type of new product under investigation (Henard & Szymanski, 2001; Poolton & Barclay, 1998). The reason being is that research findings vary with type of new product development investigated (i.e., the product innovativeness) (Atuahene-Gima, 1995; Craig & Hart, 1992; Rochford & Rudelius, 1997). The current study is focused on highly innovative products. Highly innovative products entail potentially great rewards for companies; however, little is known about the way companies should deal with their development (O'Connor, 1998; Schmidt & Calantone, 1998; Song & Montoya-Weiss, 1998; Wind & Mahajan, 1997).

This article is organized as follows. In the next section, we review relevant literature and develop the research statements. Next, we detail the methodology used to design the empirical study. Then the results are presented. We close by discussing the findings, noting contributions to new product literature and practice and suggesting future research opportunities.

2. Criteria employed to evaluate new products during the development process

In evaluating new products and making go/no-go decisions, the first steps are selecting the decision criteria and determining the respective weighting or importance of each criterion. As suggested by Rochford (1991), go/no-go criteria must be formulated before starting to discuss the project and keeping in mind objectives and limits of the different review points (in terms of information available, cost, and time).

What are the decision criteria firms use at the gates? Evidence shows that no company uses only one or two criteria to monitor ongoing projects; the majority of firms evaluate new product performance using multiple performance criteria. Firms from Balachandra, Brockhoff, and Pearson (1996) indicated to use four to seven criteria to monitor new products projects.

Regarding the number of criteria employed at the NPD gates, there is a case to suggest that early go/no-go decisions are centered on a bigger number of criteria than decisions made at the end of the NPD process. Qualitative models such as checklists and scoring models are the most common evaluation tool for the earliest gates of the NPD process (Rochford, 1991) because only a tentative commitment is required (early stages are relatively inexpensive) and because available information tends to be limited (Cooper, 2001). As known, checklists and scoring models are based on large lists of criteria. Yet, evidence in support of this case is only scant. The present study aims to fill this gap by examining the number of decision criteria employed per gate and testing the following hypothesis:

H1: Early go/no-go decisions center on a greater number of criteria than those made at the end of the NPD process.

Literature on new products as yet has not made a consistent attempt to provide insights into how go/no-go criteria are deployed throughout the NPD process. Apart from a few studies, there has been little light shed on this matter (Hart et al., 2003). Ronkainen (1985) was the first author to analyze the criteria used at making go/no-go decisions at several major review points during the NPD process. Ronkainen found that in four high-tech American companies, the use of some criteria is restricted to one particular gate, whereas some others are used at every decision-making point. The study also notes shifts in weights among three sets of criteria (market, product, and financial) as the development cycle progress. Differences in the importance attached to criteria have also been found between stages situated after the product-launch. Hultink and Robben (1995) made a distinction between measuring new product performance in the short term and in the long term after launch. They observed that some indicators of new product success are more important to measure in the short term only or in the long term. Hart et al. (2003) provide support to the work of Hultink and Robben and Ronkainen.

Notwithstanding their interesting contributions, the former studies have several limitations. Ronkainen's (1985) findings are based on a very small sample, which makes it unwise to assume their general applicability. The study by Hultink and Robben (1995) deals exclusively with stages placed after product launch. Data from study of Hart et al. (2003) study is collected at the program level rather than at the project level. In addition, their study points out variation in the usage of criteria during the NPD process; yet the statistical significance of the data is not reported. Moreover, it only investigates the usage of go/no-go criteria across several NPD gates; an obvious next step would be to measure the perceived importance of the indicators at the different gates. At this time no research has been done to substantiate whether the frequency of use of a certain criterion is related to its importance.

This study attempts to advance knowledge of how individual go/no-go criteria and criteria dimensions are deployed throughout the development process. In this respect, a number of hypotheses about the variation in the usage and importance of a set of criteria dimension have been developed. Wherever previous evidence does not indicate the contrary, it will be expected that shifts in the usage and relative importance of go/no-criteria during the NPD process follow the same pattern. Dimensions of go/no-

go criteria pertain to the following aspects: financial, strategic fit, technical feasibility, customer acceptance, and market opportunity (Griffin & Page, 1993; Hart et al., 2003; Montoya-Weiss & O'Driscoll, 2000; Rochford, 1991; Ronkainen, 1985).

The two most popular financial criteria for new product selection and prioritization decisions are payback period and discounted cash flow, which includes net present value and internal rate of return (Cooper, 2001). Empirical evidence reveals that financial criteria are rarely used to evaluate new products at the beginning of the NPD process. The study of Hart et al. (2003) indicates a lack of use of any financial criteria for the idea screening and concept test stages. The reason being is early on in the NPD process data on projected financial magnitudes are little more than educated guesses (if they exist at all) (Cooper, 2001). Interestingly, Cooper (2001), Englund and Graham (1999), and Moore (1982) remark the refusal of some firms to work with financials simply to avoid the disputes about the quality of the analysis based on such data. Near the end of the development process, as the costs of the project quickly become substantial, financial criteria weigh most in determining the potential payoff of the project (Hart et al., 2003; Ronkainen, 1985). The preceding discussion suggests that:

H2a: The usage of financial performance criteria will increase near the end of the development process.

H2b: The importance of financial performance criteria will increase near the end of the development process.

Businesses that are most likely to succeed in the development and launch of new products are those that have an articulated new product strategy. A well-defined innovation strategy specifies the goals of the new product effort and defines the strategic arenas for the business to focus on, i.e., types of market, applications, technologies, and products (Cooper, 2001). According to Cooper (2001) and Hustad (1996) the degree to which the project fits within a market or technology area defined by the business as an arena of strategic focus, should be the first criterion to use against any new product idea. If the selected projects are consistent with corporate strategy they are likely to receive support and guidance through critical phases. Also, the alignment of the project with other development projects can be better ensured (Suomala & Jokioinen, 2001). Kumar, Persaud, and Kumar (1996) study reveals that assessing the extent to which the project is congruent with firm's innovation strategy at the beginning of the NPD process is a distinguishing factor of successful new products. Thus:

H3a: Strategic fit criteria will be mostly used in the initial gates of the NPD process.

H3b: Strategic fit criteria will be more important in the initial gates of the NPD process.

Technical considerations such as technology availability and firm's technical capability can be major factors of the outcome of a new product. Respondents from Kumar et al. (1996) indicate that the firm's easy accessibility to the required technology is a vital issue to be addressed at the commercial evaluation stage. On the other hand, technical capability to handle the complexity of the project is important during the development and testing stages. According to Ronkainen (1985), technical-related criteria are the most determining go/no-go criteria during the feasibility and product/process development stages. Hart et al. (2003) show that technical feasibility is the most frequently used criterion at the approval of idea and new product concept. Thus:

H4a: Technical feasibility criteria will be mainly employed during the concept and product/process development phases.

H4b: Technical feasibility criteria will be of greatest importance during the concept and product/process development phases.

Marketing theory always has advocated in favor of a continuous orientation to the needs of the customer. Empirical research supports that businesses that track and respond to customer needs and preferences can better satisfy customers and, hence perform at higher levels (Narver & Slater, 1990). From a theoretical point of view, it is remarkable to mention that market acceptance and customer satisfaction emerge as go/no-go criteria with high usage along the whole NPD process. the study of Hart et al. (2003) showed that customer acceptance dimension permeated evaluation at all the gates in the NPD process and gained in prominence during the performance evaluation after launch. The latter finding is in line with Pinto and Slevin's (1988) study, which observed that factors such as customer needs and satisfaction become particularly important in the later phases of the project. Based on these empirical findings:

H5a: Customer acceptance criteria will be more used in the latter gates of the NPD process.

H5b: Customer acceptance criteria will gain importance in the latter gates of the NPD process.

According to Hart et al. (2003) and Ronkainen (1985), criteria indicating the probable market opportunity such as market size, market share, and market growth are decisive aspects of go/no-go decisions made early on in the NPD process. Given the high levels of investment that the development of new products entails, responding to large and attractive markets is an inherent requirement of success (Morone, 1993). The recent meta-analysis of Henard and Szymanski (2001) portrays market potential as a dominant driver of new product success. Literature on measurement criteria for the postlaunch reveals that market potential criteria are also extensively employed to evaluate new product success/failure after market launch. Page (1993) reports that sales measures and share measures are the most frequently used criteria to measure new product performance after launch. These results are in keeping with

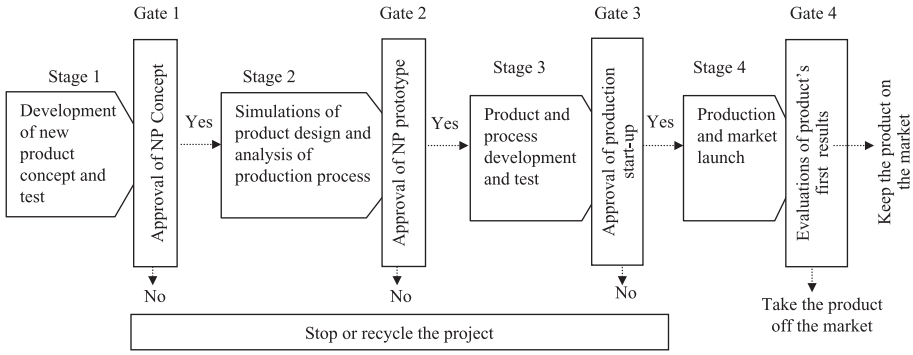

Fig. 1. New product development process.

findings from Hart et al. (2003), Hultink and Robben (1995), and Story, Saker, and Smith (1998). Hence:

H6a: Market opportunity criteria will be primarily used early on in the NPD process and after the product launch.

H6b: Importance of market opportunity will be highest early on in the NPD process and after the product launch.

3. Research method

3.1. Measurement issues and pretesting

The unit of analysis considered to answer the questionnaire was the project level. Thus, respondents were asked to base their answers on a highly innovative product that they had recently developed and commercialized. We defined a highly innovative product as that which offered new or unique benefits or solutions for market needs and involved great challenges for companies according to design and production facets of the new product development process (Schmidt & Calantone, 1998).

A standard new product development process with four go/no-go decision points was presented to the firms. As shown in Fig. 1, three review points were placed before the product launch and one review point was placed after the product launch. The review points were as follows: the approval of the new product concept, the approval of the design or formative prototype, the approval of production start-up, and the approval of keeping the product on the market (Story et al., 1998; Veryzer, 1998)[1].

A list of 16 criteria used in making go/no-go decisions was compiled from the literature (Cooper, 2001; Griffin & Page, 1993; Hart et al., 2003; Ronkainen, 1985): availability of resources, opportunity window, project alignment with firm's strategy, marketing synergies, technical/R&D synergies, project total cost for a given cycle time, product quality, product exclusivity (patentability), market acceptance, customer satisfaction, sales volume, market share, market growth, margin rate, internal rate of return, and payback time. For each of the decision points (see Fig. 1), respondents were requested to indicate which of the 16 criteria were applied. Then, the respondents were asked to allocate 100 points among the criteria chosen according to their relative importance to the go/no-go decision (Griffin & Page, 1996; Ronkainen, 1985).

All items were pretested by conducting in-depth interviews with two academics and three new products managers of 90 min each. Participants were asked to identify items that were confusing, tasks that were difficult to respond to, and any other problems they encountered. Feedback from those interviews was useful in fine-tuning the final list of evaluative criteria, the major review points and the flowchart of the development process.

3.2. Data collection and sample

The population consisted of Spanish manufacturing companies with more than 50 employees in medium- to high-technology industries: mechanical equipment, computer equipment, electrical machinery, electronic equipment, measurement instrument, motor vehicles. and other transportations (SIC-codes 34 to 38). These industries had percentages of sales and exports coming from highly innovative products higher than the average for Spanish industry (Instituto Nacional de Estadistica, 1998). According to Spanish Dunn and Bradstreet's directory of 1999 a total of 957 firms made up the population.

A questionnaire accompanied by a hand-signed cover letter and a business reply envelope was mailed to the 957 firms. The data were collected from March to June of 1999. To increase the response rate, 400 firms were contacted by phone by the end of April. Of the 400 potential respondents, about 200 firms did not develop any new products, 140 were not interested in participating in the study and 10 were companies belonging to industries not included in the research. Overall, 77 usable questionnaires were collected. Given this sample size the empirical data presented hereafter provide an exploratory test of the previous hypotheses.

Over 30% of the respondents were technical managers, 21% marketing managers, 19% CEOs, 16% R&D manag-

[1] The review points were limited to only four as a bigger number would have discouraged respondents from answering the questionnaire.

ers, and 14% production/quality managers. In general, respondents were highly experienced in the development and commercialization of highly innovative products; 90% of them were involved in the development and launch of three highly innovative products during the period comprising 1996–1998. These findings strengthen the ability of the respondents to provide well-informed answers regarding their firms' NPD practices. Forty-three percent of the responding firms belonged to the mechanical machinery and equipment industry, 22.6% to electrical machinery and equipment, 14.5% to electronics and computers, and 19.4% to motor vehicles and other transports. Almost 52% of them were independent companies and 35.5% had more than 180 employees.

The new products chosen for this study are successful. From the seven-point scale used to measure success rate (with 1 indicating "complete failure" and 7 "total success"), these products were rate on average 5.7. Fifty percent of them used either emerging technologies or a combination of multiple developing technologies and 31% employed a modification of an existing technology.

4. Results

The analysis of the criteria used in making go/no-go decisions is conducted in three parts. The first part consists of a discussion on some of the specific criteria deployed at the development gates. Second, the number of criteria firms use per gate is analyzed. Finally, the variation in the usage and the importance of the five sets of criteria from one gate of the development process to another is studied.

4.1. Go/no-go criteria employed at the NPD gates

Table 1 depicts the usage and relative importance of each go/no-go criterion at the four review points. In relation to their usage, data from Table 1 reveal that the most frequent criteria to approve the new product concept were product quality, sales volume, project total cost, alignment with firm's strategy, and window of opportunity. To approve the design or formative prototype, criteria most frequently employed were project total cost, product quality, availability of resources, and customer satisfaction. The approval of the production start-up was decided upon the following criteria: product quality, sales volume, availability of resources, and customer satisfaction. Maintaining the new product on the market was mostly decided using the following criteria: customer satisfaction, market acceptance, product quality, and sales volume. Overall, the go/no-go criteria least used during the entire NPD process were leverage of firm's marketing resources, product patentability, and payback time. With very few exceptions, data from Table 1 show that the frequency of use of a certain criterion is related to the importance of using this criterion.

4.2. Number of go/no-go decision criteria employed at NPD gates

H1 stated that early go/no-go decisions center on a bigger number of criteria than those made at the end of the NPD process. To test this hypothesis data regarding the average number of criteria employed per gate were submitted to a one-way analysis of variance. Results from the ANOVA test reveal that shifts in the number of criteria used across the

Table 1
Usage and relative importance of go/no-go criteria at the gates

	Approval of							
	New product concept		New product design		Production start-up		Keeping product on the market	
	Usage[a]	Weight[b]	Usage	Weight	Usage	Weight	Usage	Weight
Project total cost for a given cycle time	**72**	**12**	**70**	**11**	47	**9**	36	5
Availability of resources	65	6	**65**	**9**	**59**	**9**	23	3
Alignment with firm's strategy	**70**	**9**	51	5	40	6	26	3
Window of opportunity	**67**	**9**	49	6	36	4	30	4
Leverage of firm's technical resources	63	5	55	7	50	5	21	1
Leverage of firm's marketing resources	40	2	26	1	28	2	29	2
Product patentability	43	3	37	3	20	1	15	1
Product quality	**74**	**9**	**66**	**10**	**71**	**12**	**70**	**11**
Market acceptance	61	7	55	7	51	7	**71**	**14**
Customer satisfaction	61	**9**	**59**	**13**	**55**	**10**	**71**	**16**
Internal rate of return	42	4	36	5	40	6	34	6
Payback time	41	4	29	3	30	3	19	2
Margin rate	45	4	43	4	37	4	51	6
Sales volume	**72**	7	55	5	**62**	**9**	**71**	**10**
Market share	50	4	41	4	43	5	59	8
Long-term sales growth	63	8	47	5	42	5	52	8
		100[c]		100		100		100

[a] Percentage of firms that employ each criterion. The most frequently employed criteria at each gate are presented in bold.
[b] Relative importance or weight of each criterion. The most important criteria at each gate are presented in bold.
[c] For each review point, respondent were asked to distribute 100 points among the chosen criteria.

Table 2
Number of go/no-go criteria used per gate (average)

	At the approval of			
	New product concept	New product design	Production start-up	Keeping the product on the market
Number of criteria	9.3	7.8	7.1	6.8

development process are statistically significant (P=.001). Data from Table 2 show that firms consider an average of nine criteria to approve the new product's concept, almost eight criteria to approve the product's prototype, and seven criteria to approve production start-up and keeping the new product on the market. H1 is thus confirmed.

4.3. Variations in the usage and relative importance of criteria dimensions

Prior to testing hypotheses regarding the variation in the usage and importance of criteria dimensions, a factorial analysis with rotation varimax was conducted with the go/no-go criteria[2]. A five-factor solution was obtained (see Table 3). Factors were named as follows: strategic fit, technical feasibility, market opportunity, financial performance, and customer acceptance. Strategic fit dimension includes two items: alignment of project with the firm's strategy and window of opportunity. Market opportunity is made up of two items: market share and market growth. Technical feasibility dimension comprises three items: estimation of the project total cost for a given time objective, availability of resources, and leverage of firm's R&D, engineering, and manufacturing skills. Financial performance dimension includes the following items: expected margin rate, expected internal rate of return, and expected sales volume. Customer acceptance dimension pertains to whether the product meets targets of customer acceptance, targets of customer satisfaction and targets of product quality (reliability and performance). It is interesting to point out that the criteria "product quality" is linked to customer acceptance dimension. This link makes sense as customer acceptance is about whether the quality levels are acceptable to the customer and whether the product reaches acceptable performance levels for the customer (Story, Saker, & Smith, 1999). Another interesting result regards the inclusion of sales volume in the financial performance dimension. Prior to this study, others investigations had listed and used sales volume as a financial measure (Ayal & Raban, 1990; Cooper & Kleinschmidt, 1987; Hart, 1993).

To statistically test the variation in the usage and the weights of the evaluative dimensions from one gate to the next, the data were submitted to a test of differences in means for independent samples. The usage of each dimension was determined by an average of the scores for all measures comprising a specific dimension. Importance of each dimension was determined by adding the scores for all criteria comprising a specific dimension.

Fig. 2 presents the data regarding the usage of the five go/no-go criteria dimension. Results from t test reveal that the variation in the usage of financial performance from one gate to another along the NPD process is not statistically significant. Differences in the usage of the strategic dimension are statistically significant between the approval of the new product concept and approval of product design (P=.004) and between the approval of the product design and approval of production start-up (P=.064). Variations in the usage of the technical dimension between product design and production startup and between production start-up and keeping the product on the market are statistically significant (P=.067 and P=.000, respectively). The usage of market acceptance criteria differ statistically between the approval of production start-up and approval of keeping the product on the market (P=.052). Shifts in the usage of market opportunity dimension are statistically significant between the new product concept and product design (P=.070) and between the production start-up and keeping the product on the

Table 3
Factor loadings of the rotated component matrix

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
	Technical feasibility	Strategic fit	Customer acceptance	Financial performance	Market opportunity
Project total cost for a given time objective	**.40**	.13	−.26	.07	−.19
Leverage of firm's R&D/ technical resources	**.78**	.20	.04	.07	−.03
Availability of resources	**.79**	−.01	−.18	−.21	.00
Alignment with firm's strategy	.18	**.78**	.06	.05	−.15
Window of opportunity	.08	**.78**	−.13	−.16	.17
Market acceptance	−.21	.17	**.65**	.14	.00
Customer satisfaction	−.29	−.01	**.74**	−.14	−.07
Product quality	.25	−.28	**.72**	−.04	.02
Margin rate	.09	−.04	.07	**.77**	.06
Internal rate of return	−.13	−.16	−.14	**.68**	−.28
Sales volume	−.06	.11	−.04	**.60**	.43
Long-term sales growth	−.02	−.01	−.05	−.11	**.84**
Market share	−.16	−.01	.06	.47	**.64**
% variance explained	14.4	8.6	10.8	17.9	9.9

KMO = 0.621; Bartlett's test significance level =.000.

[2] Based on their low significance to making go/no-go decisions, three decision criteria were eliminated from the factorial analysis: leverage of marketing skills, product patentability, and payback time (see Table 1).

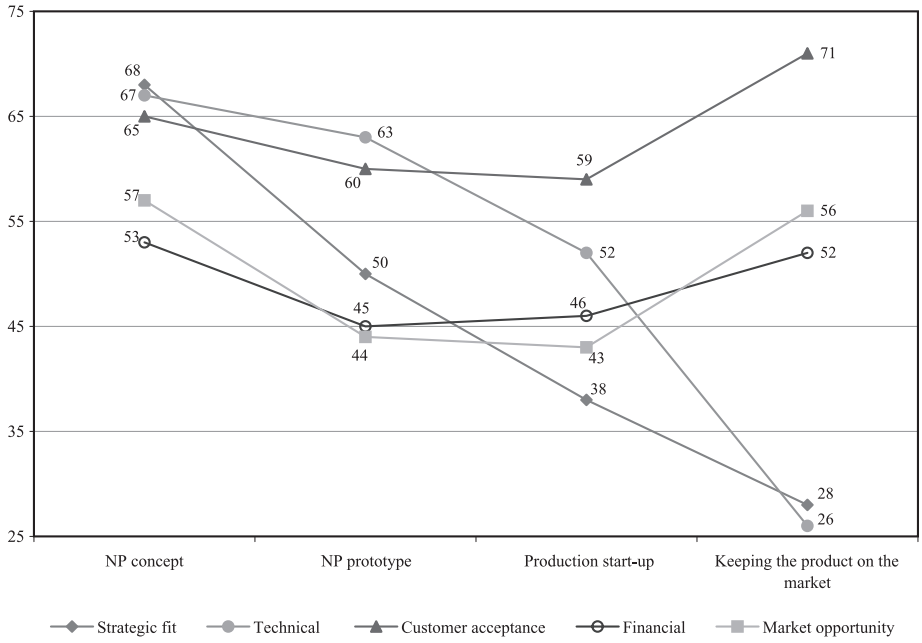

Fig. 2. Usage of the dimension of go/no-go criteria during the development process (percentage of companies).

market (P=.068). Data confirm H3a, H4a, H5a, and H6a proposing that strategic fit criteria are mostly used in the approval of new product concept, technical feasibility criteria are mainly employed during the concept and development phases, customer acceptance criteria are more used near the end of the NPD process and market opportunity criteria are primarily used early on in the NPD process and after the product launch. The findings are contrary to H2a stating that the usage of financial performance criteria increases near the end of the development process. The usage of financial performance criteria does not vary during the NPD process.

Data in relation to the importance of criteria dimensions are presented in Fig. 3. Results from t test reveal that importance given to financial performance dimension differs statistically from approval of new product prototype to approval of production start-up (P=.094). Variations in the importance of strategic dimension are statistically significant between the approval of new product concept and the approval of new product design (P=.007) and between the approval of production start-up and the approval of keeping the product on the market (P=.102). Differences in the importance scores of the technical, customer acceptance,

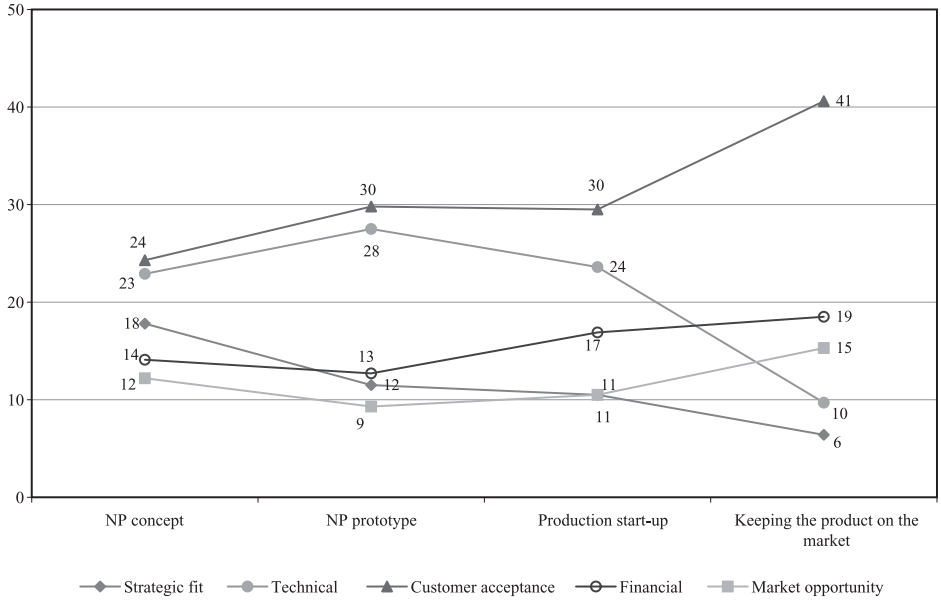

Fig. 3. Variation in the relative importance of criteria dimensions during the development process.

and market opportunity dimensions are statistically significant between the approval of production start-up and the approval of keeping the product on the market (P=.000, P=.013, P=.066, respectively). The findings provide full support for the H2b, H3b, H4b, and H5b proposing that financial performance and customer acceptance criteria are of greatest importance near the end of the development process, strategic fit criteria are most important at the beginning of the NPD process and technical feasibility criteria are more important during the concept and development stages. The findings provide partial support for hypothesis H6b stating that importance of market opportunity criteria is highest early on in the NPD process and after the product launch. It was found that importance of market opportunity criteria is highest after the product launch.

5. Discussion of results

Numerous studies have been conducted over the past three decades in an effort to increase the likelihood of new product success. However, recent studies have found that companies have not made progress in increasing the success rate of new products (Griffin, 1997). The reason is that critical activities are still missing or improperly done (Cooper, 1999). Project evaluations for example, are consistently cited as weakly handled or nonexistent: Decisions involve the wrong people from the wrong functions; nonconsistent criteria are used to screen or rank projects or there is simply no will to kill projects at all—projects are allowed to acquire a life of their own (Cooper, 1999, 2001; Englund & Graham, 1999; Johne, 1993).

This research contributes to the literature in two ways. First, it addresses a gap in the literature by examining the type of go/no-go criteria employed at various gates of the development process. Second, it provides empirical evidence of the variation in usage and importance of five dimensions of go/no-go criteria. It is worthwhile to emphasize that the referenced information regards to a sample of successful new products. Accordingly, findings from this study set out a potential set of benchmarks for companies to use when deciding the criteria to be employed to evaluate new products at gates.

This study shows that some criteria as restricted to certain gates of the development process (e.g., the usage of the criterion "window of opportunity" is limited to the approval of new product concept) whereas others are significantly employed throughout the NPD process (e.g., quality of the product, availability of resources, and sales volume). This pattern is in keeping with findings from the studies of Hart et al. (2003) and Ronkainen (1985). Further, it is noted that customer satisfaction, market acceptance, and product quality are the criteria most frequently used by the responding firms. This finding upholds results from Hart et al. (2003) and certainly accounts for the high level of success of the projects from this study. As research on success factors contends a strong customer orientation and a superior new product are highly correlated with the success of new products (Cooper, 2001; Henard & Szymanski, 2001).

Interestingly, the study reveals that firms barely employ the criterion "leverage of firm's marketing resources" to evaluate new products throughout the development process. This result is consistent with Henard and Szymanski's (2001) recent meta-analysis of the literature on new products success, which concludes that marketing synergies are more important to the success of new products in a service rather than in goods context. Another interesting result pertains to the scarce usage that respondents make of the criterion "payback period". As pointed out by Cooper (2001), for the most part highly innovative firms disregard traditional financial analysis due to the fact that it tends to understate the value of projects associated with high risks. A different explanation is the possibility that responding firms were either too impatient to see a return on a new product or too afraid to show the "truth" (Kuczmarski, 1988). In this regard, Kuczmarski (1988) suggests that firms develop a greater understanding of a new product's growth and profit cycle and become a bit more sensitized to the longer term nature of new products. A new product normally does not turn into an instant success—it takes time. The caution is to give a new product a realistic time frame in which to measure a payback period.

Regarding the dimensions of go/no-go criteria, this study shows that the usage and relative importance of go/no-go criteria dimensions change over the project's life cycle. Particularly, strategic fit dimension stands out in approving the new product concept. Technical feasibility dimension is mostly employed in approving the new product concept and the product prototype. The usage of customer acceptance dimension is notably high throughout the entire development process, particularly after the product's launch. Market opportunity dimension stands out the most in approving the new product concept and keeping the new product on the market. Importance of financial performance increases at the latter stages of the development process. Findings also suggest that the frequency of usage of a certain criterion/dimension reflects its relative importance.

As with all research, the methods employed have inherent limitations. Hence, care must be taken in generalizing our results given our small sample size. Moreover, data are retrospective and are thus susceptible to memory loss and attribution bias—respondents may not remember the exact criteria that were applied for the review of projects at different gates. Further, because the outcome of the product (success or failure) was known prior to completing the survey, there may be halo bias present. A fruitful avenue to avoid some of the problems regarding retrospective sampling would be to conduct a longitudinal study. Additional research can be developed to study the relationship between evaluation criteria usage pattern and some intermediate success variables, such as excellence in

prototype development and frequency of modification concerning NP design. Further research is also needed to detect any differences or similarities in the use of go/no-go decisions criteria. For instance, one would expect that their usage and their importance differ on the basis of the type of market served, the objectives given to the new product, the project's degree of novelty or other situation and environmental conditions.

6. Managerial implications

Selecting go/no-go decision criteria is critical in managing new products. Having a set of well-defined criteria provides a control system for comparing projects as well as symbolizes and communicates the firm's strategic intent to all the parts involved in the NPD process. Selecting go/no-go decision criteria was ranked second in importance on a list containing 24 new product development management issues of technology companies (Scott, 2000).

The results of this study have important implications for new product managers. This study demonstrates that it is insufficient to simply ask the question, "Which go/no-go criteria are most important to new product success?" It has been shown that the usage and the relative importance of various go/no-go criteria are subject to changes at different phases in the product development process. Further, this study suggests that all NPD efforts must be rooted in a clear understanding of the customer needs to be addressed. Despite the requirements and expectations of each stage of the NPD process, new product managers should build marketing inputs into every stage of the NPD process in a conscious way. This can be done by including market research to screen new product concepts and/or to refine and develop concepts, market-based concept testing, product, and preference tests undertaken with customers, test markets, or trial sells and a well-targeted market launch plan.

Acknowledgements

We are grateful for the financial support received from the financial institution CajaMurcia.

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