Marketing Letters 15:2-3, 81–97, 2004

Technology Newness and Impact of Go/No-Go Criteria on New Product Success

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Abstract

This study shows that the relative effect of five dimensions of go/no-go criteria on new product success is contingent on the stage of the development process and newness of the technology. Specifically, strategic fit criteria are critical to new product success at the initial screening. Technical criteria are significantly correlated with product success only at the go-to-development decision gate. Market opportunity criteria relate positively with project success at the initial screening, the market launch gate and the post-launch review. Financial criteria correlate positively with success from the go-to-development decision to the first post-launch review. Customer-acceptance criteria stand out as equally important to success throughout the entire development process. In relation to the moderating effect of technology newness, it was found that customer acceptance and market opportunity criteria at the initial screening are more important for the success of low technologically innovative projects than for the success of high technologically innovative projects. At the initial screening, financial criteria exert a negative effect on the success of projects incorporating highly innovative technologies.

Keywords: project selection decisions, review points, go/no-go criteria, technology newness

Introduction

Project evaluation and selection are pivotal concerns to innovative firms given the high failure rates, the rapid increases in the cost of R&D, and the need to optimize available resources (Lint and Pennings, 2001). According to Scott's (2000) study, project selection and evaluation issues were ranked second in importance on a list containing 24 management issues of technology companies.

At the heart of the project selection decisions are the go/no-go criteria that determine whether a development project is allowed to continue at any particular time. Go/no-go criteria are thus critical features of the new product development (NPD) process and the focal points of this research. As Ronkainen (1985) indicates, go/no-go criteria dictate the type

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of information to be gathered at each stage of the process, as well as which staff function is required. The usage of go/no-go criteria allows management to allocate responsibility and exercise control that reflects fairness and justice. It also ensures an understanding of the intent and expectations of data that must be supplied (Englund and Graham, 1999) and increases the quality of communication among the functions involved in the NPD process (Suomala and Jokioinen, 2001).

Despite their significance, go/no-go criteria have received little research attention. Moreover, extant studies generally centre on depicting the type of criteria employed during the development process (i.e., Ronkainen, 1985; Tidd and Bodley, 2002; Hart et al., 2003) rather than on investigating the relationship between the usage of specific criteria and new product (NP) success. As a result, limited knowledge exists of what go/no-go criteria are important in predicting success. There is a tremendous opportunity to advance understating on this field by conducting more research.

Project selection decisions involving new technologies present unique challenges for managers. It is argued that conventional go/no-go criteria (market potential, customer acceptance, profitability) have the potential to impede progress when applied to breakthrough products. These criteria are often employed to provide "decision insurance." However, their results can prove misleading when uncertainty exists concerning the nature of the technological platform, who the customer is, what the product will ultimately look like, how much it will cost, and how it will perform (Lynn et al., 1996). Further research is needed to test the significance of go/no-go criteria in guiding project selection decisions associated with breakthrough innovations.

The study presented here attempts to fulfil the two aforementioned research gaps. This study builds upon literature on new product development, project management, and market orientation to examine the relative effects of various go/no-go criteria on new product success. It is expected that the criteria's relative effect on new product success will be contingent on the stage of the development process. The study also explores the moderating effect of technology newness on the relationship between go/no-go criteria and new product success.

1. Impact of Go/No-Go Criteria on New Product Success

The subject of what go/no-go criteria are associated with new product success has been overlooked in the new product and project management literatures. Pinto and Slevin (1988) and Kumar et al. (1996) are the only two identified studies addressing this subject. Their findings show that different critical criteria are relevant to every decision point of the development process.

Notwithstanding their interesting contributions, Pinto and Slevin's (1988) and Kumar et al.'s (1996) studies have several limitations. First, in Pinto and Slevin's (1988) study, 75% of the projects for which information was collected were in progress. This means that while findings based on this data indicate the ability of the factors in predicting success at a particular stage, nothing can be said about their ability to predict the final success of the new product. As prior research indicates a significant percentage of projects that

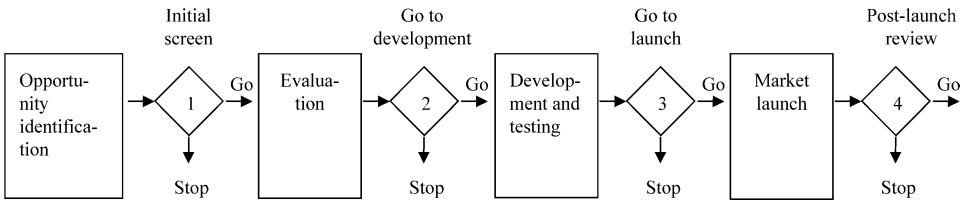

Figure 1. New Product Development Process.

make it through the NPD process, fail once in the market (Cooper, 2001). Second, the response variable in Kumar et al.'s (1996) stagewise logistic regression model consisted of all completely successful projects and failed projects at a particular decision gate. In this respect, caution should be exercised in interpreting their results in light of the small number of failed cases for each of the gates. For stages one through four, the number of failed projects was five, eight, ten and three respectively. Third, Pinto and Slevin (1988) and Kumar et al. (1996) did not develop hypotheses or theoretical reasoning for the potential effect on success of the various identifiable factors throughout the development process. Finally, findings from Pinto and Slevin (1988) and Kumar et al. (1996) pointed out the coefficients that are significantly different from zero in the regression models for each of the review points. Yet, their findings did not say anything about the significance of the difference between coefficients in different regressions; an obvious next step would be to investigate whether the relative impact of go/no-go criteria on new products differs throughout the NPD process. At this time no empirical testing has been done on this matter.

This study attempts to advance knowledge of how various dimensions of go/no-go criteria relate to new product success throughout the development process. Drawing on several research streams, a number of hypotheses have been developed about the expected impact on success of five dimensions of go/no-go criteria. In line with Ronkainen (1985), Godener and Soderquist (2001) and Hart et al. (2003), the criteria's dimensions selected are as follows: technical, strategic, customer acceptance, financial, and market-related. A four-stage process similar to the processes used by others is adopted (e.g., Kumar et al., 1996; Story et al., 1998; Lint and Pennings, 2001; Schmidt and Calantone, 1998). As shown in Figure 1, the development process is categorized into four main stages: (i) opportunity identification, (ii) evaluation stage including marketing and technical assessments, (iii) development and testing, and (iv) market launch. Between the stages, go/no-go decisions take place.

Technical considerations at the very early stages of the NPD process can be major factors in the performance of a new product. Studies by Ronkainen (1985), Pinto and Slevin (1988) and Kumar et al. (1996) revealed that technology availability (i.e., whether the technology is available and developed to the necessary level of technical sophistication) and technical capability (i.e., whether the firm has adequate technology, facilities, personnel, and troubleshooting mechanisms to support the project) were important for success during the feasibility and development stages. In keeping with this, Story et al. (1998) contended that prior to the development stage, it is critical to have an understanding of the manufacturing process and associated costs, the process technology and equipment, and the extent to which developing and manufacturing the product is feasible. Hart et al. (2003) showed

that technical feasibility was the most frequently used go/no-go criterion at the idea and concept screening stages. Thus:

H_{1a}: Accentuating technical criteria at the initial screening and go-to-development gates will have a positive impact on new product success.

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. According to Cooper (2001) the degree to which the project fits within a market or technology area of strategic focus should be the first criterion to use against any new product idea. If the selected projects are consistent with the business' strategic focus, they are likely to receive support and guidance through critical phases (Suomala and Jokioinen, 2001). Kumar et al.'s (1996) study reveals that assessing the extent to which the project is congruent with the firm's innovation strategy at the initial screening of the NPD process is a distinguishing factor of successful new products.

H_{1b}: Accentuating strategic fit criteria at the initial screening gate will have a positive impact on new product success.

Several research streams have provided insights into the importance of continuous user input to new product success. The marketing orientation literature suggests that customer-oriented product development efforts yield superior innovation and greater new product success (Gatignon and Xuereb, 1997). The network literature provides evidence that information exchange and collaboration with users throughout the life of the project are useful for new product development (Biemans, 1991). Within the new product development and project management literatures, empirical evidence depicts the development process of successful new products as one characterized by frequent and in-depth customer interactions. For example, the classic SAPPHO-project (Rothwell et al., 1974) noted that: user needs must be precisely determined and met, and it is important that these needs are monitored throughout the course of the innovation since they very rarely remain completely static. Research by Pinto and Slevin (1988) revealed that client consultation and client acceptance are key factors related to success throughout the life of the project. Hart et al.'s (2003) study showed that customer acceptance criteria permeate all evaluation gates in the NPD process. Based on these empirical findings:

H_{1c}: Accentuating customer acceptance criteria throughout the development process will have a positive impact on new product success.

Financial criteria such as expected margin, net present value, and internal rate of return are rarely used to evaluate new products at the beginning of the NPD process. Hart et al.'s (2003) study indicates a lack of use of any financial criteria for the idea screening and concept test stages. Similarly, Moore (1982) and Englund and Graham (1999) observe the refusal of some firms to work with financials at the initial screening. The reason being is early on in the NPD process, projected financial data are little more than educated guesses (Cooper, 2001). Once the costs of the project become substantial, empirical evidence shows that financial criteria weigh more in determining the potential payoff of the

project. Thus, Hart et al. (2003) pointed out that margin, profit and IRR/ROI measures were extensively used to evaluate NP at the go-to-development gate. Financial measures are also commonly employed to evaluate new products at the launch gate (Ronkainen, 1985; Cooper, 2001), and post-launch review (Griffin and Page, 1993; Tidd and Bodley, 2002). As a firm from Story et al. (1998) puts it: "Making money out of what you do is what is the ultimate measure of success." The preceding discussion suggests that:

H_{1d}: Accentuating financial criteria from the go-to-development decision to the post-launch review will have a positive impact on new product success.

The recent meta-analysis of Henard and Szymanski (2001) portrays market potential as a dominant driver of new product success. Research shows market-related criteria as decisive aspects of go/no-go decisions made early on in the NPD process. Ronkainen (1985) and Hart et al. (2003) note that criteria assessing market potential (i.e., market size and market growth) are the most frequently used criteria at the idea and concept screening stages. This finding seems to be consistent with Morone's (1993) assertion that given the high levels of investment that the development of new products entails, responding to attractive markets is an inherent requirement of success. In addition, literature on success/failure measures reveals that market criteria are broadly employed to evaluate new products after market launch. Griffin and Page (1993) report that sales and market share measures are the most frequently used criteria to gauge new product performance after launch. These results are in keeping with findings from Hart et al. (2003), Tidd and Bodley (2002), Hultink and Robben (1995) and Story et al. (1998). Hence:

H_{1e}: Accentuating market-related criteria at the initial screening and post-launch review will have a positive impact on new product success.

2. Go/No-Go Criteria and Technology Newness

Project selection decisions for breakthrough products present unique challenges for managers. Empirical evidence shows that what is beneficial practice for incremental innovations is not appropriate for breakthrough innovations. Research by O'Connor (1998) indicates that in contrast to incremental innovations, for the most part firms are not amenable to employ market-related criteria at the initial evaluation of highly innovative products. Reason is twofold. First, at this point of the NPD process, efforts are often directed to demonstrate the feasibility of the project rather than to answer questions regarding market size or market growth. Second, information on market potential for radical innovations is often unspecified and unclear and therefore neither valid nor reliable (Veryzer, 1998).

The study by Morone (1993) contends that decision-making for radical innovations should be driven by strategic imperatives rather than by financial objectives. In keeping with this, Scott (2000) argues that "conventional" financial criteria (such as ROI) do not succeed at predicting the future financial success of projects incorporating new technologies. In the same vein, Tidd and Bodley (2002) observed that the usage of financial criteria at the initial screening is more suitable for low novelty projects than for high nov-

elty projects; on the other hand, the criterion "support for strategic objective" is considered more useful for high novelty projects.

Finally, several scholars have claimed that customers do not play a major role in providing input for radical innovations in the early stages of the development process. Customers do not know what their requirements are for products that involve different behaviour patterns or open up new applications. This lack of experience often leads customers to engage in "irrational" thinking and focus on "irrelevant" attributes (Veryzer, 1998). In this respect, Jolly (1997) observed that in the context of highly innovative products, the customer's role becomes critical only when actual products start being developed. In view of the above findings, the following hypotheses are suggested:

H_{2a}: Accentuating market-related criteria at the initial screening will have a lesser impact on the success of high technologically innovative projects than on the success of low technologically innovative projects.

H_{2b}: Accentuating financial criteria at the initial screening will have a lesser impact on the success of high technologically innovative projects than on the success of low technologically innovative projects.

H_{2c}: Accentuating customer acceptance criteria at the initial screening will have a lesser impact on the success of high technologically innovative projects than on the success of low technologically innovative projects.

3. Research Method

3.1. Measurement Issues and Pretesting

The unit of analysis considered to answer the questionnaire was the project level. Respondents were asked to base their answers on an innovative product that they had recently developed and commercialized.

A list of 16 criteria used in making go/no-go decisions was compiled from the literature (Ronkainen, 1985; Griffin and Page, 1993; Cooper, 2001). For each of the decision points (see Figure 1), respondents asked to allocate 100 points among the criteria chosen according to their relative importance to the go/no-go decision (Ronkainen, 1985). Prior to testing the hypotheses, a factorial analysis with varimax rotation was conducted with the go/no-go criteria. A five-factor solution was obtained; factors were named as follows: strategic fit, technical, market opportunity, financial, and customer acceptance[1] (see Appendix). The relative importance of each dimension was determined by an average of the scores for all criteria comprising a specific dimension.

Newness of the technology was measured on a single-item scale that ranged from 1 (technologies sufficiently implemented) to 7 (new or emerging technologies) (Cooper, 1984). New product success was measured relative to four indicators: increase the firm's profits, improve the firm's image, offer a technical differential advantage, and respond to competitors' products. These items were adapted from Rockwell and Particelli (1982) and Thomas (1993) and measured on a scale that ranged from 0 ("totally unsuccessful") to

100 (“overriding success”). An exploratory factor analysis with varimax rotation was performed to check for construct validity (see Appendix). All the items loaded on one factor and their mean was used as the aggregate measure for NP success. Appendix shows the means, standard deviations, correlations, and Cronbach’s alphas values for the multi-item scales.

3.2. Data Collection and Sample

The universe of population was composed of Spanish manufacturing companies with more than 50 employees in medium-to-high technology industries: mechanical equipment, computer equipment, electrical machinery, electronic equipment, measurement instruments, and motor vehicles and other transportation (SIC-codes 34 to 38). These industries were selected since they had higher percentages of sales and exports coming from new products than the average for Spanish industry. A total of 957 firms made up our population.

A questionnaire accompanied by a hand-signed cover letter and a business envelope was mailed to each company. Data were collected from March to June of 1999. A total of 77 firms participated in the study. During the data collection period 400 companies were contacted by phone. Almost 50% of the 400 companies did not develop any new products, 31% were not interested in participating in the research and about 3% were companies belonging to industries not included in the research. Given this small sample size the empirical data presented hereafter provide an exploratory test of the previous hypotheses.

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 transportation. Almost 52% of them were independent companies and 35.5% had more than 180 employees. Respondents were highly experienced in the development and commercialization of innovative products; 90% had been involved in the development and launch of three innovative products during the two years prior to this study. These findings strengthen the ability of the respondents to provide well-informed answers regarding their firms’ NPD practices.

Product development activities in general, and evaluation activities in particular, were very important to this set of firms. Ninety-six percent of the sampled firms defined product innovation as an important or very important activity to their business. On average, new products introduced over the 1996–1998 period accounted for 54% of 1998 sales. Eighty-one percent of the firms indicated that new product projects were evaluated on a regular and systematic basis and 82% of them noted that new product performance was systematically measured after the product launch. For 70% of the firms, new product evaluation activities were deemed important for the success of their new products. In relation to each evaluation gate, 72% of the firms ranked the initial screening as quite important. Seventy-six percent, 78%, and 50% of the firms described the go-to-development decision, go-to-market decision, and post-launch review, respectively, as quite important for the success of their new products.

We used Armstrong and Overton (1977) time-trend extrapolation procedure to test for nonresponse bias. In comparing early (first quartile) and late (fourth quartile) respondents,

Table 1. Impact of Decision Criteria on New Product Success at Four Gates in the NPD Process (Standardized Regression Coefficients)

	Gate 1 Initial screening	Gate 2 Go-to-development	Gate 3 Go-to-market	Gate 4 Post-launch review
Go/no-go dimension				
Technical	0.05	0.40^{**}	0.00	−0.08
Strategic fit	0.33^{**}	−0.04	0.05	0.02
Customer acceptance	0.26^{*}	0.30^{*}	0.24^{*}	0.26^{*}
Financial	−0.14	0.18^{+}	0.30^{*}	0.42^{**}
Market opportunity	0.40^{**}	0.08	0.23^{*}	0.18^{+}
R^2	0.40	0.19	0.21	0.32
F-value	8.90	3.00	3.56	6.08
Significance	0.000	0.017	0.007	0.000

Significance: $^{**}p < 0.01$, $^{*}p < 0.05$, $^{+}p < 0.10$.

no significant differences emerged in the mean responses on any of the constructs. These results suggest that nonresponse bias was not a major problem.

4. Results

4.1. Impact of Go/No-Go Criteria on New Product Success

Hypotheses H_{1a} to H_{1e} were tested by analyzing the results of four separate multiple linear regression models, one for each of the review points. The general model used to test these propositions was:

$$\begin{aligned}\text{NP success} = {} & \alpha_{\text{Gate}i} \cdot \text{Technical}_i + \beta_{\text{Gate}i} \cdot \text{Strategic}_i + \gamma_{\text{Gate}i} \cdot \text{Customer}_i \\ & + \delta_{\text{Gate}i} \cdot \text{Financial}_i + \varepsilon_{\text{Gate}i} \cdot \text{Market}_i + \nu_{\text{Gate}i} \end{aligned} \quad (1)$$

with $i = 1, 2, 3, 4$.

Here technical, strategic, customer, financial, and market are the independent variables of interest and represent the relative importance of the technical, strategic fit, customer acceptance, financial, and market opportunity dimensions respectively; ν represents the error term.

Table 1 shows that technical dimension is positively correlated with new product success at the go-to-development decision ($\alpha_{\text{Gate2}} = 0.40$, $p < 0.01$). Strategic fit dimension is positively associated with new product success at the initial screening ($\beta_{\text{Gate1}} = 0.33$, $p < 0.01$). Customer acceptance dimension is positively associated with new product success at each and every of the review points ($\gamma_{\text{Gate1}} = 0.26$, $p < 0.05$; $\gamma_{\text{Gate2}} = 0.30$, $p < 0.05$; $\gamma_{\text{Gate3}} = 0.24$, $p < 0.05$; $\gamma_{\text{Gate4}} = 0.26$, $p < 0.05$). Importance given to financial dimension is positively associated with new product success at the go-to-development decision ($\delta_{\text{Gate2}} = 0.18$, $p < 0.10$), go-to-market decision ($\delta_{\text{Gate3}} = 0.30$, $p < 0.05$) and post-launch review ($\delta_{\text{Gate4}} = 0.42$, $p < 0.01$). The relative importance of market opportunity correlates positively with the new product success at the initial screening

Table 2. Chow-Test Values and Significance Levels

Go/no-go dimension	Gates					
	1 & 2	1 & 3	1 & 4	2 & 3	2 & 4	3 & 4
Technical	2.86 (0.059)	n.s.	n.s.	2.83 (0.062)	2.68 (0.072)	n.s.
Strategic fit	3.60 (0.030)	3.62 (0.029)	4.44 (0.014)	n.s.	n.s.	n.s.
Customer acceptance	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Financial	2.92 (0.057)	6.31 (0.002)	6.85 (0.001)	n.s.	2.43 (0.092)	n.s.
Market opportunity	3.17 (0.045)	n.s.	n.s.	n.s.	n.s.	n.s.

($\varepsilon_{\text{Gate1}} = 0.40$, $p < 0.01$), go-to-market decision ($\varepsilon_{\text{Gate3}} = 0.23$, $p < 0.05$), and post-launch review ($\varepsilon_{\text{Gate4}} = 0.18$, $p < 0.10$).

The different regression coefficients and significance levels reported in Table 1 suggest that the stage of the process could have a moderating effect on the impact of go/no-go criteria's relative importance on new product success. A formal way of testing for the equality of coefficients of different regressions is given by the Chow-test (Chow, 1960). Parameter estimates for each criteria dimension were compared to each other to determine if coefficients were significantly different throughout the development process. Table 2 demonstrates the results of the Chow-test.

Regarding the technical dimension, results in Table 2 reject the null hypothesis that the regression coefficient at gate two is identical to the coefficients at the other three gates at 10% significance. Results from the Chow-test show that the strategic fit coefficient at gate one is significantly different from the parameters at the other three gates at 5% significance. Results from the Chow-test accept the null hypothesis that regression coefficients for customer acceptance criteria do not differ significantly throughout the development process. For the financial dimension, the Chow-test reveals that regression coefficient at gate one is significantly different from the parameters at the other three gates and that the regression coefficient at gate two is significantly different from the coefficient at gate four. For the market opportunity dimension, results from the Chow-test indicate that regression coefficient at gate one is significantly different from parameter at gate two. No significant differences where found between the other pairs of gates. Overall, data show that with the exception of the customer acceptance dimension, the regression coefficients of the go/no-go criteria's dimensions do change across the evaluation gates. Table 4 summarizes the results for hypotheses H_{1a} to H_{1e}.

4.2. Moderating Effect of Newness of Technology

Hierarchical moderated regression analysis was used to test the effect of the technology newness on the relationship between importance given to go/no-go criteria and new prod-

uct success (hypotheses H_{2a} to H_{2c}). The interaction variables were entered in the regression model along with their constituent elements to take into account their main effect. The moderation hypotheses were tested by examining the significance of the interaction coefficient estimates. The general model used to test these propositions was:

$$\begin{aligned}\text{NP success} = {} & \alpha_{\text{Gate}i} \cdot \text{Technical}_i + \beta_{\text{Gate}i} \cdot \text{Strategic}_i + \gamma_{\text{Gate}i} \cdot \text{Customer}_i \\ & + \delta_{\text{Gate}i} \cdot \text{Financial}_i + \varepsilon_{\text{Gate}i} \cdot \text{Market}_i + \lambda \cdot \text{Newness} \\ & + \theta_{\text{Gate}i} \cdot \text{Technical}_i \cdot \text{Newness} + \mu_{\text{Gate}i} \cdot \text{Strategic}_i \cdot \text{Newness} \\ & + \rho_{\text{Gate}i} \cdot \text{Customer}_i \cdot \text{Newness} + \phi_{\text{Gate}i} \cdot \text{Financial}_i \cdot \text{Newness} \\ & + \eta_{\text{Gate}i} \cdot \text{Market}_i \cdot \text{Newness} + \nu_{\text{Gate}i} \end{aligned} \quad (2)$$

with $i = 1, 2, 3, 4$.

Here, technical, strategic, customer, financial, and market represent the relative importance of the technical, strategic fit, customer acceptance, financial, and market opportunity dimensions, respectively. Newness represents the degree of newness of the technology employed during the development and ν is the error term. Prior to the creation of the interaction terms, the variables were mean-centred to reduce potential problems of multicollinearity. Variance inflation factors (VIFs) were also calculated to examine the extent to which nonorthogonality among the independent and moderator variable inflated standard errors. These VIFs are all below the recommended cutoff point of 5, suggesting the multicollinearity is unlikely a threat to the substantive conclusions drawn from the results.

Results from Table 3 show a negative interaction effect between market opportunity criteria and technology newness at gate one ($\eta_{\text{Gate1}} = -0.26$, $p < 0.05$) and at gate two ($\eta_{\text{Gate2}} = -0.26$, $p < 0.10$) providing support for H_{2a}. The nature of this interaction was examined using the Aiken and West (1991) procedure. This procedure tests for the significance of regression-coefficient estimates for the independent variable at one standard deviation below and above the mean of the technology newness moderator. At a low level of technology newness, Aiken and West (1991) revealed a strong significant positive relationship between market opportunity criteria and new product success at gate one ($\varepsilon_{\text{Gate1}} = 0.69$, $p < 0.01$) and at gate two ($\varepsilon_{\text{Gate2}} = 0.52$, $p < 0.05$). At a high level of technology newness, a lack of relationship was found at the aforementioned gates.

A negative interaction effect was found between financial criteria and technology newness at gate one ($\phi_{\text{Gate1}} = -0.22$, $p < 0.05$), which supports H_{2b}. Once again, we used the Aiken and West (1991) procedure to examine the nature of this interaction. At a low level of technology newness, the Aiken and West's (1991) procedure revealed a lack of relationship between financial criteria and new product success, whereas at a high level of technology newness a strong negative relationship was found ($\delta_{\text{Gate2}} = -0.62$, $p < 0.01$).

As predicted in H_{2c}, a negative interaction effect was found between customer acceptance criteria at gate one and technology newness ($\rho_{\text{Gate1}} = -0.19$, $p < 0.10$). At a low level of technology newness, results from Aiken and West (1991) indicated a positive relationship ($\gamma_{\text{Gate1}} = 0.33$, $p < 0.10$) between customer acceptance criteria and new product success, whereas at a high level of technology newness the relationship between customer acceptance criteria and new product success was not significant. Table 4 summarizes the predictions of hypotheses H_{2a} to H_{2c} and the estimated effects.

Table 3. Moderated Regression Analysis: Effect of Technological Newness (Standardized Regression Coefficients)

	Gate 1 Initial screening	Gate 2 Go-to-development	Gate 3 Go-to-market	Gate 4 Post-launch review
Main effects				
Technological newness	−0.16	−0.22	0.07	0.16
Technical	−0.01	0.28*	.00	−0.16
Strategic fit	0.29**	−0.10	0.01	0.10
Customer acceptance	0.27**	0.27*	0.26*	0.20+
Financial	−0.22*	0.21+	0.30*	0.45**
Market opportunity	0.35**	0.07	0.25*	0.12
R^2	0.414	0.212	0.236	0.339
Interaction effects				
Technical × technology newness	0.04	0.14	−0.19	−0.05
Strategic fit × technology newness	0.13	0.26*	0.16	0.08
Customer × technological newness	−0.19+	0.04	−0.16	0.19
Financial × technology newness	−0.22*	−0.19	0.10	0.05
Market × technology newness	−0.26*	−0.26+	−0.20	0.16
Change of R^2	0.129	0.133	0.063	0.051
Sig. R^2 change	0.009	0.049	n.s.	n.s.
Significance	0.000	0.005	0.018	0.001

Significance: $^{**}p < 0.01$, $^{*}p < 0.05$, $^{+}p < 0.10$.

5. Discussion

It is recognized that the subject of what criteria to use in evaluating new products has considerable practical interest for companies. To the extent that these criteria are derived from the corporate and new product strategy of the firm and are focused on the specific requirements of each stage of the NPD process, they can help reduce managerial uncertainty and can identify areas where additional attention and resources are needed (Hart et al., 2003).

This study makes three significant contributions to the literature on go/no-go criteria. It is first to develop theoretical hypotheses about the expected impact on new product success of various dimensions of go/no-go criteria throughout the development process and the moderating effect of technological newness. Second, it empirically tests the significance of the difference in go/no-go criteria's relative effect on NP success between evaluation gates. Third, it provides empirical evidence on the moderating effect of technological newness on the relationship between the criteria's relative importance and new product success. By doing so, this study refines and extends understanding of the outcomes of the criteria used at making go/no-go decisions.

This research shows that critical go/no-go criteria are different at every stage of the development process. Particularly, strategic fit dimension stands out as a vital determinant of success in approving the new product idea. Technical criteria are significantly correlated with product success at the go-to-development decision gate. Market opportunity criteria

Table 4. Summary of Hypotheses, Predicted Effects and Estimated Effects

	Predicted effects	Estimated effects	
H_{1a}: Accentuating technical criteria at the initial screening and go-to-development gates will have a positive impact on NP success	$\alpha_{Gate1}, \alpha_{Gate2} \neq 0$[a]	$\alpha_{Gate2} \neq 0$ $\alpha_{Gate2} > \alpha_{Gate1}, \alpha_{Gate3}, \alpha_{Gate4}$	Partially confirmed
H_{1b}: Accentuating strategic fit criteria at the initial screening gate will have a positive impact on NP success	$\beta_{Gate1} \neq 0$[a]	$\beta_{Gate1} \neq 0$ $\beta_{Gate1} > \beta_{Gate2}, \beta_{Gate3}, \beta_{Gate4}$	Confirmed
H_{1c}: Accentuating customer acceptance criteria throughout the development process will have a positive impact on NP success	$\gamma_{Gate1}, \gamma_{Gate2}, \gamma_{Gate3}, \gamma_{Gate4} \neq 0$[a]	$\gamma_{Gate1}, \gamma_{Gate2}, \gamma_{Gate3}, \gamma_{Gate4} \neq 0$ $\gamma_{Gate1} = \gamma_{Gate2} = \gamma_{Gate3} = \gamma_{Gate4}$	Confirmed
H_{1d}: Accentuating financial criteria from the go-to-development decision to the post-launch review will have a positive impact on NP success	$\delta_{Gate2}, \delta_{Gate3}, \delta_{Gate4} \neq 0$[a]	$\delta_{Gate2}, \delta_{Gate3}, \delta_{Gate4} \neq 0$ $\delta_{Gate2}, \delta_{Gate3}, \delta_{Gate4} > \delta_{Gate1}$ $\delta_{Gate4} > \delta_{Gate2}$	Confirmed
H_{1e}: Accentuating market-related criteria at the initial screening and post-launch review will have a positive impact on NP success	$\varepsilon_{Gate1}, \varepsilon_{Gate4} \neq 0$[a]	$\varepsilon_{Gate1}, \varepsilon_{Gate3}, \varepsilon_{Gate4} \neq 0$ $\varepsilon_{Gate1} > \varepsilon_{Gate2}$	Confirmed
H_{2a}: Accentuating market-related criteria at the initial screening will have a lesser impact on the success of high technologically innovative projects	$\eta_{Gate1} < 0$[b]	$\eta_{Gate1}, \eta_{Gate2} < 0$	Confirmed
H_{2b}: Accentuating financial criteria at the initial screening will have a lesser impact on the success of high technologically innovative projects	$\phi_{Gate1} < 0$[b]	$\phi_{Gate1} < 0$	Confirmed
H_{2c}: Accentuating customer-acceptance criteria at the initial screening will have a lesser impact on the success of high technologically innovative projects	$\rho_{Gate1} < 0$[b]	$\rho_{Gate1} < 0$	Confirmed

[a] From equation (1) NP success $= \alpha_{Gatei} \cdot \text{Technical}_i + \beta_{Gatei} \cdot \text{Strategic}_i + \gamma_{Gatei} \cdot \text{Customer}_i + \delta_{Gatei} \cdot \text{Financial}_i + \varepsilon_{Gatei} \cdot \text{Market}_I + \nu_{Gatei}$.

[b] From equation (2) NP success $= \alpha_{Gatei} \cdot \text{Technical}_i + \beta_{Gatei} \cdot \text{Strategic}_i + \gamma_{Gatei} \cdot \text{Customer}_i + \delta_{Gatei} \cdot \text{Financial}_i + \varepsilon_{Gatei} \cdot \text{Market}_i + \lambda \cdot \text{Newness} + \theta_{Gatei} \cdot \text{Technical}_i \cdot \text{Newness} + \mu_{Gatei} \cdot \text{Strategic}_i \cdot \text{Newness} + \rho_{Gatei} \cdot \text{Customer}_i \cdot \text{Newness} + \phi_{Gatei} \cdot \text{Financial}_i \cdot \text{Newness} + \eta_{Gatei} \cdot \text{Market}_i \cdot \text{Newness} + \nu_{Gatei}$.

relate positively with project success at the initial screening, the market launch gate, and the post-launch review. Emphasizing financial criteria have a positive impact on new product success from the go-to-development gate to the first post-launch review; yet it is shown that the relative effect of financial criteria on new product success is significantly bigger in the latter evaluations. Finally, results show that placing importance on customer acceptance criteria correlates positively with project success at every stage of the process.

Regarding the moderating effect of technological newness, findings suggest that accentuating market opportunity criteria early on in the development process has less impact on new product success for high technologically innovative products than for low technologically innovative products. This is consistent with Veryzer's (1998) and Deszca et al.'s (1999) studies arguing that traditional approaches to assessing markets are inaccurate and unreliable and have the potential to impede progress when applied to breakthrough projects. It also supports Song and Montoya-Weiss's (1998) findings noting that extensive market opportunity analysis is associated with decreases in the profitability of radical innovation. Findings also imply that putting emphasis on customer-based input for the approval of the new product idea undermines the success of technologically innovative projects. Herewith, it should be noted that this is not to say that understanding customer needs is totally unimportant to the success of highly innovative products. As mentioned by Deszca et al. (1999), breakthrough products will only contribute positively to a company's competitive position if they address customer needs and offer superior value. Accordingly, findings show that beyond the initial screening, importance given to customer acceptance criteria correlates positively with new product success. Finally, it is observed that underlining the financial dimension to consent to the new product idea has a negative impact on the success of breakthrough projects while stressing the strategic fit dimension has a positive impact. This supports Morone's (1993) assertion that selection decisions for radical innovations are best shaped by strategic considerations rather by expected financial performance.

There are limitations to the study that need to be raised. First, care must be taken in generalizing the results given our small sample size. Second, the reliability coefficients for the criteria dimensions were only moderate. This requires that the interpretation of the results be more conservative and provides motivation for future research to replicate the study with stronger and more reliable constructs. Third, in spite of the age of the data, the study makes several important contributions and has the potential for generating additional research that takes a new direction. Fourth, the average rating for the variable "technology newness" is 4.4 on a 1–7 scale. This is marginally above the mid-point, which suggests that the products are not particularly new. However, the analysis of the frequency response for technology newness indicates that 49% of the cases are at five or above and only 28% of the cases are at three or below. These results should mitigate any concern as to whether the data really represent new products. Finally, data are retrospective and thus susceptible to memory loss; respondents may not remember the exact criteria that were applied to the review of projects at different gates.

Future research should address the limitations of this study. For instance, a fruitful avenue to avoid some of the problems regarding retrospective sampling would be to conduct a longitudinal study to investigate actual new product projects over their development

cycle. Furthermore, there is potential for developing a more extensive list of go/no-go criteria that includes market size, brand equity, image, social responsibility or ethical matters. Moreover, not all potential moderators of the effect of the evaluation criteria on new product success have been explored here. Future research could focus on four categories of variables: (1) industry (consumer goods, new services), (2) the firm (new product strategy, development driver), (3) the project (nature of the objectives pursued), and (4) the market in which a firm competes (intensity of industry competition). Finally, there is little empirical information on the type of decision-making unit (e.g., individual, team) and the functional backgrounds of the gatekeepers. More work is needed on identifying who makes the continuation or termination decisions.

Acknowledgments

We are indebted to the editor and two anonymous reviewers for their thoughtful and very helpful comments on earlier versions of this paper. This research was supported by a research grant from the financial institution CajaMurcia.

Appendix

Table A.1. Varimax Rotation for Go/No-Go Criteria[a]

Go/no-go criteria	Factorial loadings	% variance explained
Factor 1: Technical		
Availability of resources	0.79	14.4%
Leverage of firm's technical resources	0.78	
Project total cost for a given cycle time	0.40	
Factor 2: Strategic fit		
Alignment with firm's strategy	0.78	8.6%
Window of opportunity	0.78	
Factor 3: Customer acceptance		
Customer satisfaction	0.74	10.8%
Product quality	0.72	
Market acceptance	0.65	
Factor 4: Financial		
Margin rate	0.77	17.9%
Internal rate of return	0.68	
Sales volume	0.60	
Factor 5: Market opportunity		
Market growth	0.84	9.9%
Market share	0.64	

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

Table A.2. Varimax Rotation for New Product Success

	Factorial loadings	% variance explained
To increase firm's profits	0.60	54%
To improve firm's image	0.86	
To offer a technical differential advantage	0.74	
To respond to competitors' launching products	0.73	

Table A.3. Means, Standard Deviation, Cronbach's Alpha and Zero-Order Correlations

	Mean	S.D.	Cronbach's alpha[a]	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) New product success	62.9	19.9	0.71	1.00						
(2) Technical criteria	21.0	22.2	0.68	−0.01	1.00					
(3) Strategic criteria	11.6	15.0	0.51**	0.07	0.21**	1.00				
(4) Customer acceptance criteria	31.0	25.4	0.77	0.21**	−0.26**	−0.11+	1.00			
(5) Financial criteria	17.6	17.5	0.64	0.17**	−0.12*	−0.15*	−0.02	1.00		
(6) Market opportunity criteria	11.8	14.8	0.43**	0.27**	−0.15*	0.05	0.00	0.18**	1.00	
(7) Technological newness	4.4	1.6	–	0.17**	0.05	−0.01	0.01	−0.00	0.09	1.00

Significance levels: ** $p < 0.01$, * $p < 0.05$, + $p < 0.10$.
[a] Correlation coefficients are shown for scales containing fewer than 3 items.

Note

1. It is interesting to point out that the criterion "sales volume" is linked to the financial performance dimension as opposed to the market opportunity dimension. Prior to this study, other investigations had listed and used sales volume as a financial measure (Hart, 1993). 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). The inclusion of the criterion "product quality" in the customer acceptance dimension 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 et al., 1999).

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