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Criteria Deployment at Evaluation Gates Under different New Product Development Strategies

Kung-Jeng Wang
Department of Industrial Management
National Taiwan University of Science and Technology, Taipei, Taiwan

Yun-Huei Lee
Department of Business Administration, Tamkang University, Taipei, Taiwan
E-mail: yh@mail.tku.edu.tw
Tel: +886-022-9830331; Fax: +886-022-26215656

Abstract

Effective project evaluation is critical to successful new product programs and the importance of evaluation gates during the NPD process has been widely recognized. However, many firms still fail in their NPD projects by suffering from inaccurate and/or inappropriate criteria deployment. This study examines the relation between perceived importance and actual implement of evaluation gates for NPD performance, and also investigates what are the most frequently used and appropriate evaluation criteria at development gates throughout the NPD process under different new product strategies. Based on a survey of 87 successful new product projects, the results show that there exists significant difference between the perceived importance and actual implement in the low-performance group. More importantly, the aggregated results across new product strategies indicate that some evaluation categories are mainly applied in approving particular stage, whereas some others are used notably high in approving every stage. Specifically, market criteria are frequently used in pre-commercialization testing, and post-launch review gates. Financial criteria frequently appear in decision on business case and post-launch review gates. Technical criteria noticeably figure in the product testing and pre-commercialization testing gates. Time criteria emerge only in the pre-commercialization testing gate. Opportunity criteria have no position in the ranked list. Finally, we conclude with theoretical contributions and managerial implications.

Keywords: New Product Strategy; Criteria Deployment; Evaluation Gate

1. Introduction

New product development is regarded as an important strategy that can lead to a corporation's long term success (Chang & Yong, 1991). It is widely agreed that the development of new products is of increasing importance to profitability and competitiveness, especially for large manufacturers in such technology-intensive industries as electronic components, communications, photonics, semiconductor and information technology. As the characteristic of risk of high failure rate is embedded in new product development (NPD) process, managers have recognized that effective project evaluation is critical to successful new product programs (Cooper, 2001). Introducing the evaluation gate taken place between each development stage is a method for managing the risks of new products (Crawford, 1989; de Brentani, 1986; Kuczmarski, 1988; O' Connor, 1996), and the evaluation criteria within the

gate is used to assess performance from corresponding development stage stages in order to determine the go/no-go decision and accelerate the accuracy of the project.

The importance of evaluation gates during the NPD process has been recognized (Hart et al., 2003; Tzokas et al., 2004), yet many firms still fail in the NPD project. The reason is that the firm would have conducted improper implement activities (Cooper, 1984; Cooper & Kleinschmidt, 1991). As so far few researchers have paid attention on the state that actual implement of evaluation gates, there is an opportunity to further investigate the extent of implement for each evaluation gate, and to advance the understanding of the relation between perceived importance and actual implement on NPD success. Moreover, not all new products are the same (Kleinschmidt & Cooper, 1991). Whereas some new products are perceived by customers to be slight improvements over competitive products, other products are new to the world. Extant studies almost focused on exploring how evaluation criteria are employed throughout the NPD process (e.g., Hart et al., 2003; Hauser et al., 2006; Hultink et al., 2000; Pilar et al., 2004; Ronkainen's, 1985; Tzokas et al., 2004), however, little is known on the matter that research results vary with the type of new product development (Atuahene-Gima, 1995; Craig & Hart, 1992; Rochford & Rudelius, 1997). Therefore, our aim is to further examine what are the most frequently used and appropriate evaluation criteria to new product success under different new product strategies. This study here shed light on two aforementioned research gaps.

Semiconductor, information technology, communications and photonics are prominent industries in Taiwan well known all over the world. To further promote competitiveness, those hi-tech firms are actively struggling to cultivate innovative capability, and striving to be a research and development (R&D) organization. R&D investment is the primary way adopted by Taiwan's manufacturing firm's for innovation (Tsai & Wang, 2007). The success of new products depends mostly on the NPD process and management (Kalpana & Rajan, 2000), for the sake of navigating NPD process, the quest of evaluation criteria at each evaluation gate is strongly perceived attention. Therefore, we in this paper focus on hi-tech industry in Taiwan to research on this field, and expect to provide not only Taiwan, but also other newly industrialized nations like Korea, Singapore and India with useful guidelines as well as suggestions.

The remainder of this article is organized as follows. Section 2 conveys relevant literature and develops the research statements that guided the research. Section 3 is a discussion of the research methodology, sample characteristics, and measures. In section 4 the results of the investigation are presented. Then section 5 of the article provides conclusions, limitations of the study and future research directions.

2. Previous Research

2.1. NPD Process

A common NPD process is subdivided into many stages. Between each stage, there is an evaluation gate to determine whether the new product should advance further or be terminated (Cooper & Kleinschmidt, 1986; Page, 1993). An overview of a Stage-Gate system are idea, initial screen, preliminary assessment, second screen, detailed investigation (business case preparation), decision on business case, development, post-development review, testing and validation, pre-commercialization business analysis, full production and market launch, and post-implementation review (Cooper, 1990).

Booz et al. (1982) were the first to indicate that the new product process was a key to successful new product performance. For example, Northern Telecom, a leading firm in the field of product development, implemented their four-stage gating system for new product, and then obtained prominent results: shorter times to launch, fewer mistakes, less recycling and rework in the process, and a more successful development effort. Evaluation gates manage risks derived from innovation (Crawford, 1989; de Brentani, 1986; Kuczmarski, 1988; O'Connor, 1996), monitor quality of the project, and avoid go/no-go errors during the development process (Cooper, 2001). Within each gate,

criteria are used to evaluate new product and make go/no-go decisions. It is widely recognized that implementing a Stage-Gate process will achieve a much higher level of new product performance.

2.2. Evaluation Criteria for NPD Gates

The subject on the measurement of NPD performance has been one of research streams over the past decades (e.g., Barczak, 1995; Calantone et al., 1995; Cooper, 1984; Cooper & Kleinschmidt, 1996; Cusumano & Nobeoka, 1991; Driva et al., 2000; Griffin & Page, 1993; Gruner & Homburg, 2000; Sbragia, 1984; Kusunoki et al., 1998; Loch et al., 1996; Millson & Wileman, 2002; Olson, et al., 1995; Page, 1993; Swink, 2000; Song, et al., 1998; Souder et al., 1998). It is reasonable to argue that the indicators of NPD performance are the basis of evaluation criteria used in NPD gates. Ronkainen (1985) divided evaluation criteria of NPD gates into three categories, including product, market, and finance. Hauser and Zettelmeyer (1997) pointed out that the best metrics depend on the goals of different types of research, development, and engineering activities (i.e., projects, programs, and explorations). The dimensions of metrics include strategic goals, quality/value, people, process, customer, and revenues/costs. Hart et al. (2003) and Tzokas et al. (2004) grouped evaluation criteria into five dimensions: market-based, financial-based, product-based, process-based, and intuition-based. Factorial analysis was conducted with the go/no-go criteria in Pilar et al.'s work (2004). Five dimensions of evaluation criteria are technical feasibility, strategic fit, customer acceptance, financial performance, and market opportunity. This study has summarized typical evaluation criteria for NPD gates and listed in Appendix 1. It indicates that product, market, and finance are the most important set of measures for evaluating NPD outcome. However, the extent as well as criteria deployment of perceived importance and actual implement of evaluation gates is worthy to investigate.

2.3. New Product Strategy

New product strategy has been operationalized as the types of new products developed by a firm that denotes the innovativeness of the new products (Barczak 1995). For instance, there are different categories of new products that can be placed on a continuum from pioneering to incremental innovation. Ansoff (1957) proposed a framework with newness to the market and newness to the company, grouping new products into six distinct categories: (1) new to the world: new products that create and entirely new market; (2) new product to a company: new products that allow a company to enter an established market for the first time; (3) additions to existing product lines: new products that supplement a company's established product lines; (4) improvement and revisions to exiting products: new products that provide improved performance or greater perceived value and replace existing products; (5) repositioning: existing products targeted to new markets or market segments; (6) cost reduction: new products that provide similar performance at lower cost. Song and Montoya-Weiss (1998b) utilized Ansoff's product market matrix model to enable the growth in market and technology.

Other researchers have devised different classifications to label a product's degree of innovativeness. For example, Crawford and Di Benedetto (2002) suggested five types of new products: (1) new to the world product (i.e. inventions); (2) new categories entries: product new to the firm, but not new to the world; (3) additions to product lines: products that are line extensions, flankers in the firm's current markets; (4) product improvement: current products made better; (5) repositioning: products that are retargeted for a new use or applications. Besides, Kleinschmidt and Cooper (1991) developed a triad categorization to capture varying levels of innovativeness and a firm's new product strategy. The types of innovation are distinguished into: (1) highly innovative products including new-to-the-world products and new to the firm lines; (2) moderately innovative products consisting of lines new to a firm, but not new to the world and improvement items in existing product lines; (3) low innovative products including all product modifications, cost reductions and repositionings.

In principle, too complicated type of data will lead to a difficulty in comparing, explaining, and representing results, however too simple type of data will ignore differences among results. According

to the abovementioned frameworks of new product strategy, we concluded that commonly used new product strategies used should be popularized, developed, and involved by innovation companies. Among them, a classification on three types of strategies - highly innovative products, moderately innovative products, and low innovative products are highly recommended.

2.4. Research Issues

Effective project evaluation is critical to a successful new product project. Prior research indicated that a phased review process is commonly used (Cooper, 1990; Griffin, 1993). Nowadays, the concept of evaluation gates incorporated into the new product development has received significant attention (Cooper, 2001; Griffin, 1997), and evaluation gates have become necessary steps in the NPD process. A project cannot pass into the next stage until the evaluation is done and the gate is opened. The entrance to each stage is a gate; these gates control the process, much like quality control checkpoints control the production process (Cooper, 1990). Implementing gates can ensure no critical errors are omitted, and then have a high performance. Therefore, the fact that importance and implement of evaluation gates are crucial factors for NPD success cannot be denied. Based on this rationale we expect that the high level of perceived importance and actual implement on evaluation gates during NPD process will affect NPD performance. In the meanwhile, we are interesting to investigate the extent as well as criteria deployment of perceived importance and actual implement of evaluation gates from the perspective of sample frame.

In addition, Griffin and Page (1996) suggested that the measures for assessing project-level success depend on the project strategy. For instance, the ranking of the importance showed that market share, revenue or satisfaction, to meet profit goal, and competitive advantage are the most appropriate set of measures for evaluating NPD outcome under new-to-the-company strategy. Hauser and Zettelmeyer (1997) concluded that metrics that are best for one type of activity may be counter productive for another type. Atuahene-Gima (1995), Craig and Hart (1992), and Rochford and Rudelius (1997) indicated that research results vary with type of new product development. It is logical to consider that evaluation criteria are derived from the firm's new product strategy and are centered to the specific requirements of each stage of the NPD process. Therefore, in this paper, we will investigate that which criteria are used most frequently at the NPD evaluation gates alongside the various new product strategies.

3. Methodology

3.1. Measure Development

In this study, a pool of items was provided by a questionnaire asking respondents to provide background information and NPD project characteristics. Most of the questions in the document were patterned after items found from literature search and interviews with academics and practitioners. The questionnaire was pretested with several academics and NPD executives. The participants were asked to examine the initial questionnaire in order to eliminate/revise confusing questions and identify interpretation problems. By the end of the pretest, the questionnaire was ready for final administration.

3.2. Study Measures

3.2.1. NPD Process and Corresponding Evaluation Gates

For the NPD process, the respondents were asked to indicate the extent to which they engaged in particular activities when developing a new product. A NPD process is made up of development stages (idea generation, detailed business case, product development, testing and validation, and commercialization) (also refer to Hart et al., 2003, and Tzokas et al., 2004) and corresponding evaluation gates (initial screening, decision on business case, product testing, pre-commercialization testing, and post-launch review separately).

3.2.2. Perceived Importance and Actual Implement for Each Evaluation Gate

NPD executives were asked to answer that the degree of perceived importance and actual implement they thought for five evaluation gates. We used 5-point Likert scale that adapted from (Barczak, 1995) to measure items. The scale ranges from 1 (extremely unimportant) to 5 (extremely important). Moreover, the level of actual implement for each evaluation gate was also measured by a scale from 1 (no implement) to 5 (highly implement).

3.2.3. Criteria of each Evaluation Gate

Respondents were asked to answer the questions based on their successful NPD project that had fully launched. Evaluation criteria were adapted from the literature (Hart et al., 2003; Griffin & Page, 1993; Tzokas et al., 2004). These indicators were grouped into five categories: market category includes customer satisfaction, customer acceptance, sales objectives, sales growth, market share, sales volume, market potential; financial category consists of break-even time, profit objectives, internal rate of return, margin rate; technical category is composed of product performance, quality, product uniqueness, technical feasibility; time category comprises stay within budget, introduced in time, time to market; opportunity category is made up of marketing chance, intuition. The items scales were adapted from Hart et al. (2003) and Tzokas et al. (2004). We calculate the frequency of each evaluation criterion used in each gate, and present the frequent table with % under three new product strategies.

3.2.4. New Product development Performance

NPD performance is a multifaceted construct (Griffin & Page, 1996). Respondents were asked whether their new products tended to fall below, meet, or exceed sales, profit, and market share goals. These three measures have been identified by Griffin and Page (1993, 1996) as core measures of new product performance. Overall satisfaction with their firms' NPD effort has also been identified as an appropriate measure of performance in the study. The construct was measured using 5-point scale (1=strongly disagree, 5= strongly agree). To ensure the reliability of the performance variable, Cronbach's alpha was used. The coefficient is 0.84. Alphas>0.7 indicate high reliabilities according to Nunnally (1978).

3.2.5. New Product Strategy

New product strategy was measured by asking respondents to indicate which one of three strategies they tend to use for their new product project. The three strategies offered were (1) highly innovative products: new-to-the-world products and new to the firm lines; (2) moderately innovative products: lines new to a firm, but not new to the world and existing items in existing product lines; (3) low innovative products: product modifications, cost reductions and repositionings. These measures have been used by Cooper (1991).

3.3. Data Collection

Our sampling frame encompasses manufacturing companies in Taiwan with more than 50 employees; firms with less than 50 employees were not chosen because they are more likely to have more idiosyncratic new product development activities. The industries including electronic, communication, photonics, semiconductor and information technology are with high percentages of sales coming from new products through a variety of NPD strategies. A total of 250 questionnaires were mailed to NPD executive of firms selected from commercial address list, and 87 were complete to be used for the analysis, yielding a valid response rate of 34.8%.

The sample can be described as follows: on average, 23% of the responding firms belonged to the electronic, 18% to communication, 20% to photonics, 18% to semiconductor, and 21% to information technology. Moreover, 80% of the respondents had been with the company for more than 5 years. This implies that the respondents have sufficient experiences and knowledge to provide us NPD practices. It is revealed that 36% of the respondents developed highly innovative products, 34%

of them engaged in moderately innovative products. Only 30% of the products involved low innovative products.

To test the impact of possible non-response biases, responses of early and late waves of returned surveys were compared. This commonly used method is based on the assumption that the opinions of late responders are representative of non-respondents (Armstrong & Overton, 1977). The tests indicated no significant differences across the groups for any of the variables (at 95% confidence level). Thus, we conclude that non-response biases do not appear to be a major problem in this study.

4. Results

4.1. Perceived Importance and Implement for each Evaluation Gate

For the purpose of estimating the research models for hypotheses testing first, a sample of companies listed in Tehran Stock Exchange for the time period of 2001-2003 is used. Second, a sample of state companies is used. We estimate the research models with pooled data for three years, and overall 647 years-firm. Then, similarly the models are estimated for sample companies in different industrial groups. Finally, we estimate the research models using cross-sectional data for each year (2001 to 2003). We estimate the research models for the sample of state companies in the same way.

4.2. Perceived Importance and Implement for each Evaluation Gate

Table 1 illustrates the results of investigating the perceived importance and actual implement at evaluation gates. The result shows that the gates: decision on business case (M=4.09) and product testing (M=4.32) are perceived as two most important for their successful new product projects, and in keeping with this, these gates are implemented extensively (M=4.06 and 3.83 separately). The finding is consistency with prior literature that lay more weight on customer's requirements for the new products (Wheelwright & Clark, 1994). Moreover, as the majority of our sample frame is the firms with highly and moderately innovative strategies, the gate (decision on business case) is critical to be used to assess market, technical and financial possibilities. Therefore, it is important for the managers that when proceed a new product project, they have to emphasize not only on requirements of the product, but also on the business analysis with regard to various contributions.

In addition, to examine all grouping possibilities, a reasonable clusters-hierarchical clustering technique was employed without having to look at all configurations. In this study, we grouped the samples into two groups: high-performance group and low-performance group in terms of the scores of NPD performance. Data in relation to the differences between perceived importance and actual implement under two groups are presented in Table 2. Results from t test reveal that there is no significant difference in the high-performance group between the perceived importance and actual implement (p=0.091), whereas, there has significant difference in the low-performance group between the perceived importance and actual implement (p=0.014). From statistically numerical analysis we find the fact that the level of perceived importance is higher than the level of actual implement, and mean values confirm this result. (M=0.8908>0.7059).

Table 1: Perceived importance and actual implement at each evaluation gate

Evaluation Gate	Variable	Mean	SD
Initial screening	Importance	3.92	0.94
	Implement	3.62	1.92
Decision on business case	Importance	4.09	0.91
	Implement	3.83	0.92
Product testing	Importance	4.32	0.81
	Implement	4.06	0.99
Pre-commercialization testing	Importance	4.05	0.93
	Implement	3.82	0.98
Post-launch review	Importance	3.72	1.00
	Implement	3.62	1.06

Table 2: The differences between perceived importance and actual implement under two groups

Group	Variable	Mean	SD	P value
High-performance	Importance	3.9850	0.4797	0.091
	Implement	3.9524	0.4771	
Low-performance	Importance	3.8908	0.9707	0.014*
	Implement	3.7059	1.0660	

Significance levels:* p<0.05.

4.3. Frequently used Criteria at each Evaluation gate under new Product Strategies

Table 3 shows the results that what evaluation criteria are frequently used at each evaluation gate of the NPD process under different new product strategies. Below, we will discuss the three most frequently used criteria at the different NPD evaluation gates under three types of new products.

In the initial screening gate, market potential, technical feasibility, and product uniqueness are the frequently used criteria in the three product strategies. At this gate the manager hopes to choose a right idea of preventing technically non-feasible and unattractive to the market for further NPD. Our research confirms that a qualified idea should be feasible and desirable from technical and market

Table 3: The frequently used criteria at each evaluation gate under three new product strategies

Product Strategy / Evaluation Gate	Highly Innovative Strategy		Moderately Innovative Strategy		Low Innovative Strategy	
	criterion	%*	criterion	%	criterion	%
Initial screening	Market potential	58.06	Market potential	60	Product uniqueness	42.31
	technical feasibility	58.06	technical feasibility	50	Market potential	38.46
	product uniqueness	35.48	product uniqueness	46.67	Technical feasibility	34.62
Decision on business case	Sales volume	45.16	Profit objectives	56.67	Profit objectives	46.15
	profit objectives	45.16	Sales objectives	43.33	Sales volume	38.46
	Sales objectives	41.94	Internal rate of return	43.33	Margin rate	34.62
Product testing	Quality	54.84	Quality	56.67	Quality	61.54
	Technical feasibility	41.94	Technical feasibility	50	Technical feasibility	42.31
	Product performance	35.48	Product performance	50	Product performance	30.77
Pre-commercialization testing	Customer satisfaction	41.94	Customer satisfaction	53.33	Quality	38.46
	Time-to-market	35.48	Customer acceptance	53.33	Customer satisfaction	34.62
	Customer acceptance	29.03	Quality	40	Customer acceptance	34.62
Post-launch review	Customer satisfaction	51.61	Customer satisfaction	50	Customer acceptance	42.31
	Market share	48.39	Market share	40	Sales volume	38.46
	Profit objectives	41.94	Internal rate of return	40	Sales growth	34.62

*%: The number of firms that make use of the criterion, divided by the number of firms with highly/moderately/low innovative strategy.

5. Conditions

In the decision on business case gate, the manager has to decide whether the project should be killed or not before entering heavy spending, as once past this gate, the commitment of resources are substantial. A detailed, formal analysis regarding financial conditions must convince the firm to invest necessary resource to advance a development of new products. Highly innovative products potentially entail great rewards for companies, thus, the criteria with regard to financial level are the most important evaluation prospect. Accordingly, this research indicates that the firms with the highly innovative strategy use sales volume, profit objectives, and sales objectives to assess; profit objective, sales objectives, and internal rate of return are the criteria most frequently used in the firms with moderately

innovative strategy; those with low innovativeness use three frequently used criterion: profit objectives, sales volume, and margin rate.

In the product testing gate, the managers need to examine the design and manufacturing of prototypes in order to ensure the functionality of the product from internal technical and manufacturing requirements. Not surprising, firms would check on product quality and product performance, test and debug the production process, and monitor production costs and rates. Thus, without doubt, results indicate that firms with any kind of product strategies use criteria most frequently at this gate are quality, technical feasibility, and product performance.

In the pre-commercialization testing gate the prototype is provided to its potential customers to test whether it has market potential. The managers expect to obtain responses for market, technical and process aspects of the product. It is of paramount importance to gauge potential customer's reaction to the product. By getting useful suggestions, the firm can continue further improvement, and then progress to the next stage of the NPD process. The mainly most frequently used criteria at this gate are customer satisfaction as well as customer acceptance and quality. In addition, in order to stand on fist-mover position, the firm with highly innovative strategy also evaluate the criterion, time-to-market, extensively. By getting useful suggestions, the firm can continue further improvement, and then proceed to the next stage of the NPD process.

In the post-launch review gate, the criteria most frequently used include market-related and financial-related consideration. By understanding whether the product is accepted and satisfied by customers, and whether customer's willing is reflected on the sales, the manager will determine that the product must be terminated, or becomes a "regular product" in the firm's line. It is obviously clear that the evaluation criteria are shifted from initial screening gate to now; the firms are prone to use customer, sales and profit levels to assess instead of technical levels. It is logical, because new product has been established well in the marketplace, its product performance has been verified, and sales is to appear a state of robustness, in the long term the manager not only continues to track customer's reaction, but also mainly aims for pursuing substantial rewards derived from the new product, and for pursuing a leading competitive position. Therefore, the most frequently used criteria in the firms with highly innovative strategy are customer satisfaction, market share and profit objectives. Customer satisfaction, market share and internal rate of return are the criteria most frequently used in the firms with moderately innovative strategy. The firms with low innovative strategy use three frequently used criteria: customer acceptance, sales volume and sales growth.

Conclusions

This study has contributed to the NPD research in three aspects. First, it has simultaneously investigated the level of perceived importance and actual implement at NPD evaluation gates. Second, it has empirically tested the significance of the difference between the perceived importance and actual implement from the perspectives of high-performance and low-performance groups. Third, it has provided a complete picture of deployment of evaluation criteria at each gate during the NPD process under three types of new product strategies: highly innovative strategy, moderately innovative strategy, and low innovative strategy.

According to our research outcomes, the product testing gate is perceived of highly importance and highly implement by the respondents. Due to heavy pressure from customer's requirement to the product itself (i.e., compatibility) and drastic market competition, this reflects management efforts to meet technical and manufacturing requirements. Further, decision on business case gate is ranked second in both perceived importance and actual implement on a NPD process containing five evaluation gates. This is in line with Song and Montoya-Weiss's (1998b) study arguing that strategic planning is the significant determinant of new products success. This research also reveals that there exists significant difference between the perceived importance and actual implement in the low-performance group. This result also supports Cooper's (1999) finding noting that the reason that the

firm fails in new products is because critical activities are still missing or improperly done. For instance, project evaluations are consistently cited as weakly managed or nonexistent.

This investigation has revealed the preference of the deployment of evaluation criteria at each gate under different strategies. The similarities that were found in this study across new product strategies may demonstrate the consistency of the findings. Market criteria permeate the entire NPD process and are more used in the late gates of the NPD process, e.g. pre-commercialization testing and post-launch review gates. From a theoretical point of view this is noteworthy, because that the needs of the customer has to be continuous attention is always advocated by marketing theory (Moenaert & Souder, 1990). Financial criteria appear in decision on business case and post-launch review gates. Evaluation criteria of a financial nature may assist management to identify substantial commitments on heavy spending, and to compare latest data on revenues, costs, expenditure, and profits with projections to gauge performance. Cooper and Kleinschmidt (1986) mention that financial criteria are important indicators to determine that the product must be terminated, or becomes a "regular product" in the firm's line. Technical criteria noticeably figure in the product testing and pre-commercialization testing gates. It is expected as it reflects management efforts to identify of problems that have to do with go-errors and drop-errors, and prevent non-feasible and incorrect specifications. Hauser et al. (2006) note that product performance, quality, product uniqueness, and technical feasibility are important indicators for the customer's satisfaction. Time criteria emerge in the pre-commercialization testing gate. This is because the firm encounters pressures from time and money. Nowadays, shorter product life cycle makes the speed of NPD be a critical factor of competition (Wheelwright & Clark, 1992). Moreover, to maintain reputation, continued viability, short-term profits and cash flow, the firm would launch their products at a regular period. Due to resource scarcity, NPD is restricted to limited expenditure. Current firms thus would monitor and control budget spending on development stages. Opportunity criteria have no position in the ranked list. These results are almost keeping with findings from the studies of Hart et al. (2003), Ronkainen (1985), and Tzokas et al. (2004).

The results of this study emerge several managerial implications. First, managers should struggle to implement evaluation criteria so that problems and go-errors are detected and prevented. Further, the referenced information related to a sample of successful new products, accordingly, the findings from this study provide managers better understanding of how evaluation criteria are employed and deployed. Managers should compare and contrast the results with their own NPD strategies to navigate their new product process.

There are several directions in need of further attention. First, we should undertake a large-scale survey to strengthen the generalizability of the results. Although our research may not fully allow for a valid conclusion on the link between to the importance – implementation to the three different strategies, we have tested for this relation in order to see if some significant differences seem to exist. Since each strategy is represented by limited number of companies, a larger sample and a more exploratory type of research might reveal differences in future work. Moreover, not all evaluation criteria are included in this study, there is possible for developing a more detailed list of criteria, such as customer participation, supplier involvement, business image etc. Finally, our research explores research questions in certain condition: new product strategy, following works could investigate whether the deployment of criteria at each gate varies with situational (i.e. organizational structure) and environmental (i.e. industry) conditions.

References

[1] Amstrong, J.S. and Overton, T.S. (1977). Estimating nonresponse bias in mail surveys. Journal of Marketing Research, 4, 396-402.

[2] Atuahene-Gima, K. (1995). An exploratory analysis of the impact of market orientation on new product performance: A contingency approach. Journal of Product Innovation Management, 12, 275-293.

[3] Ansoff, H.I. (1957). Strategies for diversification. Harvard Business Review, 35(5), 113-124.
[4] Barczak, G. (1995). New product strategy, structure, process, and performance in the telecommunications Industry. Journal of Product Innovation Management, 12(2), 224-234.
[5] Booz-Allen and Hamilton (1982). New Product Management for the 1980s. New York, NY: Booz-Allen & Haniliton.
[6] Calantone, R., Vickery, S., & Droge, C. (1995). Business performance and strategic new product development activities: an empirical investigation. Journal of Product Innovation management, 12(3), 214-223.
[7] Chang, Z.Y., & Yong, K.C. (1991). Dimensions and indices for performance evaluation of a product development project, International Journal of Technology Management, 6(12), 155-168.
[8] Crawford, C.M. (1989). Evaluating new products: a system, not an act. Business Horizons, 29(6), 48-55
[9] Crawford, C.M. (1994). New Product Management (4th ed). Burr Ridge Illinois: Irwin, Inc.
[10] Crawford, C.M., & Di Benedetto, C.A. (2002). New Products Management (7th ed). New York, NY: Mcgraw-Hill Inc.
[11] Cooper, R.G. (1984). The strategy-performance link in product innovation. R&D Management, 14(4), 247-259.
[12] Cooper, R.G. (1990). Stage-gate systems: A new tool for managing new products. Business Horizons, 33(3), 44-54.
[13] Cooper, R.G. (2001). Winning at new products: accelerating the process from idea to launch, 3rd edition. Massachusetts: Perseus Publishing.
[14] Cooper, R.G., & Kleinschmidt, E.J. (1986). An investigation into the new product process: steps, deficiencies, and impact. Journal of Product Innovation Management, 3, 71-85.
[15] Cooper, R.G., & Kleinschmidt, E.J. (1990). New products: the key factors in success. Chicago: American Marketing Association.
[16] Cooper, R.G., & Kleinschmidt, E.J. (1991). New process at leading industrial firms. Industrial Marketing Journal, 20, 137–147.
[17] Cooper, R.G., & Kleinschmidt, E.J. (1996). Winning business in product development: the critical success factors. Research Technology Management, 39(4), 18-29.
[18] Craig, A., & Hart, S. (1992). Where make a new product winner: Success factor at the project level. European Journal of Marketing, 26, 3-39.
[19] Cusumano, M.A., & Nobeoka, K. (1992). Strategy, structure and performance in product development: observations from the auto industry. Research Policy, 21(3), 265-293.
[20] De Brentain, U. (1986). Do firms need a custom-designed new product screening model? Journal of Product Innovation Management, 3, 108-119.
[21] Driva, H., Pawar, K.S., & Menon, U. (2000). Measuring product development performance in manufacturing organizations, International Journal of Product Economics, 63, 147-159.
[22] Griffin, A. (1993). Metrics for measuring product development cycle time. Journal of Product Innovation Management, 10(2), 112-125.
[23] Griffin, A., & Page, A.L. (1993). An interim report on measuring product development success and failure. Journal of Product Innovation Management, 10(4), 291-308.
[24] Griffin, A., & Page, A.L. (1996). PDMA's success measurement project: Recommended measures by project and strategy type. Journal of Product Innovation Management, 13(6), 478-496.
[25] 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.
[26] Gruner, K.E., & Homburg, C. (2000). Does customer interaction enhance new product success? Journal of Business Research, 49, 1-14.

[27] Hauser, J.R., & Zettelmeyer, F. (1997). Metrics to evaluate RD&E. Research-Technology Management, 12, 392-405.
[28] Hart, S., Hultink, E.J., Tzokas, N., & Commnadeur, H.R. (2003). Industrial companies' evaluation criteria in new product development gates. Journal of Product Innovation Management, 20, 22-36.
[29] Hauser, J., Tellis, G.J., & Griffin, A. (2006). Research on innovation: a review and agenda for marketing science. Marketing Science, 25(6), 687-717.
[30] Hultink, E. J., Hart, S., Robben, H. S. J., & Griffin, A. (2000). Launch decisions and new product success: An empirical comparison of consumer and industrial products. Journal of Product Innovation Management, 17, 5-23.
[31] Kalpana, J.C., & Rajan, Y.S. (2000), New product development: challenges of globalization, International Journal of Technology Management, 19(7-8), 788-805.
[32] Kleinschmidt, E.J., & Cooper, R.G. (1991). The impact of product innovativeness on performance. Journal of Product Innovation Management, 8(4), 240-251.
[33] Kuczmarski, T.D. (1988). Managing new products: Competing through excellence. New Jersey: Prentice Hall.
[34] Kusunoki, K., Nonaka, I., & Nagata, A. (1998). Organizational capabilities in product development of Japanese firms: a conceptual framework and empirical findings. Organization Science, 9(6), 699-718.
[35] Loch, C., Stein, L., & Terwiesch, C. (1996). Measuring development performance in the electronics industry. Product Innovation Management, 13, 3-20.
[36] Millson, M.R., & Wilemon, D. (2002). The impact of organizational integration and product development proficiency on market success. Industrial Marketing Management, 31, 1-23.
[37] Moenaert, R.K., & Souder, W.E. (1990). An information transfer model for integrating marketing and R&D personnel in NPD projects. Journal of Product Innovation Management, 7(2), 91-107.
[38] Nunnally, J. C. (1978). Psychometric theory. New York, NY: McGraw-Hill.
[39] O'Connor, G.C. (1998). Market learning and radical innovation: a cross case comparison of eight radical innovation projects. Journal of Innovation Management, 15(2), 151-166.
[40] Olson, E.M., Walker Jr, O.C., & Ruekert, R.W. (1995). Organizing for effective new product development: the moderating role of product innovativeness. Journal of Marketing, 59(1), 48-62.
[41] Page, A.L. (1993). Assessing new product development practices and performance: establishing crucial norms. Journal of product Innovation Management, 10, 293-290.
[42] Pilar, C.F., Munuera-Aleman, J.L., & Rodriguez-Escudero, A.I. (2004). Criteria employed for go/no-go decisions when development successful highly innovative products, Industrial Marketing Management, 33(4), 307–316.
[43] Ronkainen, I.A. (1985). Criteria changes across product development stages. Industrial Marketing Management, 14, 171-178.
[44] Sbragia, R. (1984). Clarity of management roles and performance of R&D multidisciplinary projects in matrix structures. R&D Management, 14(2), 113-126.
[45] Song, X.M., Thieme, R.J., & Xie, J. (1998a). The impact of cross-functional joint involvement across product development stages: an exploratory study. Journal of Product Innovation Management, 15, 289-303.
[46] Song, X.M., & Montoya-Weiss, M.M. (1998b). Critical development activities for really new versus incremental products. Journal of Product Innovation management, 15(2), 124-135.
[47] Souder, W.E., Sherman, J.D., & Cooper, R.D. (1998). Environmental uncertainty, organizational integration, and new product development effectiveness: a test of contingency theory. Journal of Product Innovation Management, 15(6), 520–533.

[48] Swink, M. (2000). Technological innovativeness as a moderator of new product design integration and top management support. Journal of Product Innovation Management, 17(3), 208–220.
[49] Tsai, K.H., & Wang, J.C. (2007), A longitudinal examination of performance of two ways on innovation in Taiwan: internal R&D investment and external technology acquisition. International Journal of Technology Management, 39(3/4), 235-247.
[50] Tzokas, N., Hultink, E.J., & Hart, S. (2004). Navigating the New Product Development Process. Industrial Marketing Management, 33(7), 619– 626.
[51] Wheelwright, S.C., & Clark, K.B. (1992). Accelerating the design-build-test cycle for effective product development. *International Marketing Review*, 11(1), 32-46.

Appendix 1. The Dimensions and Indicators of NPD Gates

Scholar	Dimensions	Indicators
Ronkainen (1985)	Product	Exclusivity, performance/feasibility, ease of service, legality, organizational support, and safety
	Market	Size, growth rate, relation to present product lines, expected competitive situation, distribution characteristics, and special political and social factors
	Finance	ROI, effect on cash flow, total investment requirement, and payback
Hauser and Zettelmeyer (1997)	Strategic goals	Match to organization's strategic objectives, scope of the technology, effectiveness of a new system, counts of innovations, patents, refereed papers, competitive response
	Quality/value	Quality of the research, peer review or research, benchmarking comparable research activities, gate success of concepts, percent of goal fulfillment, yield
	People	Quality of the people, managerial involvement
	Process	Productivity, timely response, internal process measures, deliverables delivered, fulfillment of technical specifications, time for completion, speed of getting technology into new products, time to market, time of response to customer problems
	Customer	Relevance, customer satisfaction, service quality, number of customers who found faults
	Revenues/costs	Revenue of new product in 3 years/R&D cost, Percent revenues derived from 3-5 year-old-products, gross margin on new products, economic value added, bread-even after release, cost of committing further, overhead cost of research
Hart et al. (2003); Tzokas et al. (2004)	Market-based	Customer acceptance, customer satisfaction, sales objectives, sales growth, market share, sales in units, market potential
	Financial-based	Bread-even time, profit objectives, IRR/ROI, margin
	Product-based	Product performance, quality, product uniqueness, technical feasibility
	Process-based	Stay within budget, introduced in time, time-to-market
	Intuition-based	Marketing change, intuition
Pilar et al.'s work (2004)	Technical feasibility	Project total cost for a given time objective, leverage of firm's R&D/technical resources, availability of resources
	Strategic fit	Alignment with firm's strategy, window of opportunity
	Customer acceptance	Market acceptance, customer satisfaction, product quality
	Financial performance	Margin rate, internal rate of return, sales volume
	Market opportunity	Long-term sales growth, market share