
Does Customer Interaction Enhance New Product Success?

Kjell E. Gruner
PORSCHÉ AG

Christian Homburg
UNIVERSITY OF MANNHEIM

Recent years have witnessed a resurgence of academic and practitioner interest in new product development and in the way companies interact with their customers. While there has been considerable scientific progress in both research areas, very limited attention has been given to customer interaction in the new product development process as a means to increase new product success. This article reports on research assessing the performance impact of (1) the intensity of customer interaction in different stages of the new product development process and (2) the characteristics of the involved customers. The research is based on field interviews as well as statistical analyses of a sample in the machinery industry. Results indicate that customer interaction during certain stages (but not others) of the new product development process has a positive impact on new product success. The characteristics of the involved customers have a significant effect on new product success as well. As an example, collaborating with financially attractive customers or customers exhibiting lead user characteristics increases new product success. J BUSN RES 2000. 49.1–14. © 2000 Elsevier Science Inc. All rights reserved

Relationship marketing and interaction between business partners has recently received widespread interest among researchers and managers alike (see, e.g., Lusch and Brown, 1996). Some authors even suggest that these emerging ways of doing business are a new marketing paradigm (Grönroos, 1994) that represents “a fundamental reshaping of the field” (Webster, 1992, p. 1). Another shift of focus in marketing is that “after a decade of restructuring and reengineering, with an emphasis on cutting assets and personnel, the new priority is renewal and growth through innovation” (Day, 1996, p. 15). Given the importance of both relationship

marketing and innovation, research exploring the effect of customer interaction in the context of new product development should be of particular relevance to the development of marketing thought. The research reported in this article was motivated by the question of whether and how success can be increased by interacting with customers in the specific context of new product development.

Some companies report on the success of such activities. For example, Boeing interacted closely with its customers (the airlines) during the development process for its new Boeing 777 airplane (Condit, 1994). Analyzing performance impact of customer interaction in new product development on a more general level (i.e., beyond isolated examples) can yield important managerial insights.

This article investigates empirically the impact of customer interaction on success in new product development. Due to the paramount importance of the process perspective for new product development (e.g., Saren, 1994), we will analyze the performance impact of customer interaction at different stages of the new product development process. The choice of the partner is another core aspect of interacting with customers. As an example, von Hippel (1988) focuses on innovating with customers exhibiting “lead user” characteristics. Also, Heide and John (1990, p. 34) pointed out that “bilateral governance is not universally desirable.” We will therefore investigate the impact of customer characteristics on new product success as the second major research question.

The first section outlines the theoretical background of the study, which is based on resource dependence theory. The literature review focuses on relationship marketing, studies on new product success, and lead user research. Subsequently, our own study will be presented. We conducted preliminary field interviews and a subsequent survey. After measure validation, the results of the analyses related to our research questions are discussed. The concluding section is devoted to a discussion of theoretical and managerial aspects of the study.

Address correspondence to Christian Homburg, Director of the Institute of Market-Oriented Management, Chair of the Marketing Department, Universität Mannheim, D-68131 Mannheim, Germany. Tel: ++49-621-181-1555; Fax: ++49-621-181-1556; E-mail: prof.homburg@bwl.uni-mannheim.de

Limitations and possibilities for future research are also discussed.

Theoretical Background

Our study can be related to resource dependence theory (Pfeffer and Salancik, 1978) that has had a significant influence on work in the fields of buyer–supplier and manufacturer–distributor relationships. This theory, being rooted in the open systems perspective of organization theory (Scott, 1992), proposes that a firm's survival is contingent on its ability to gain control over environmental resources. Possible resources include funding, personnel, information, products and services, and authority (Aldrich, 1976, p. 419). The dependence typically results out of several factors:

Three factors are critical in determining the dependence of one organization on another: First, there is the importance of the resource, the extent to which the organization requires it for continued operation and survival. The second is the extent to which the interest group has discretion over the resource allocation and use. And, third, the extent to which there are few alternatives (Pfeffer and Salancik, 1978, p. 45).

In resource dependence theory, “organizations are viewed as active, not passive, in determining their own fate” (Scott, 1992, p. 114). Further it is argued that organizations develop strategies to cope with dependence. The main premise of resource dependence theory is that firms will seek to manage dependence and reduce the resulting uncertainty by purposely structuring their exchange relationships by means of establishing formal or semiformal links with other firms (Ulrich and Barney, 1984). Conceptually, the establishment of an interfirm link is viewed as dealing with the problems of uncertainty and dependence by deliberately increasing the extent of coordination with the relevant set of exchange partners (Cyert and March, 1963; Pfeffer and Salancik, 1978, p. 43).

Thus, according to resource dependence theory, one of the fundamental strategies to reduce dependence is coordination with the resource owner. Scott (1992) calls those activities “bridging strategies” that are implemented to secure critical resources:

... among the most important actions organizations can take is the modification of their boundaries, more or less drastically and more or less formally. These interactions include boundary-spanning and boundary-shifting strategies that bridge between organizations and their exchange partners ... (Scott, 1992, p. 197).

In the context of our study, information on customer needs and user experiences might be viewed as resources companies depend upon for successfully developing new products. From the discussion of the three factors determining the dependence of a company on resources, a high dependency on customer information can be concluded for three reasons. First, cus-

tomers related information is highly important for continued operation in the present context. Second, the customers have discretion over the resource. Third, customer related information can only be obtained from customers themselves. Cooperation with customers thus can be viewed as a bridging strategy to secure access to the critical resource of information on customer needs. According to resource dependence theory, this strategy increases organizational effectiveness and thus performance. For our purposes, the main implication of resource dependence theory is a theoretical justification for our fundamental hypothesis that customer interaction has a positive impact on new product success.

Literature Review

The literature review covers three areas of research. First, studies in relationship marketing are discussed because information exchange and collaboration are key constructs in this research stream. Second, studies of new product success are discussed because they yield first insights concerning the performance implications of customer interaction. The literature review concludes with a short discussion of lead user analysis.

Studies in Relationship Marketing

New product development is a central issue in collaborative relationships between firms. As an example, Anderson, Haskansson, and Johanson (1994) describe the development of a business network that emerged when a new product was developed and tried together with customer firms. Heide and John (1990) investigated determinants of joint action in alliances between buyers and sellers. To operationalize the dependent variable joint action, a formative scale with three items was developed. One of those refers to component testing/prototyping (Heide and John, 1990, p. 30).

More generally, research in relationship marketing highlights the importance of information exchange and cooperation in business relationships. Mohr and Nevin (1990, p. 36) called communication “the glue that holds together a channel of distribution.” Anderson and Narus (1990) stressed the crucial role of communication in partnerships for the formation of cooperation and trust. With respect to cooperation, Morgan and Hunt (1994, p. 26) state: “Effective cooperation within a network promotes effective competition among networks. Therefore, cooperation promotes relationship marketing success.” This hypothesis has been generally confirmed in empirical research (e.g., Anderson and Narus, 1990; Heide and Stump, 1995; Kalwani and Narayandas, 1995). Thus, studies in relationship marketing (although typically not related to new product development) provide theoretical and empirical evidence that information exchange and collaboration may promote success thus supporting the logic that customer interaction in new product development yields positive outcomes. This provides support for the proposition developed in this article.

Additionally, a significant body of research in relationship

marketing emphasizes the impact of partner characteristics on relationship outcomes (e.g., Mohr and Spekman, 1994). In particular, the importance of the partner's reputation has been highlighted in a number of studies (Doney and Cannon, 1997; Ganesan, 1994). Other partner characteristics that have been emphasized in previous research include the readiness to exchange information (Lusch and Brown, 1996; Morgan and Hunt, 1994) and the length of the relationship (Doney and Cannon, 1997). Thus, research in the area of relationship marketing also provides evidence that the choice of a cooperation partner has to be made carefully. This supports the relevance of our second research question.

A remaining question is to what extent our study can draw upon research in the area of relationship marketing by adopting previously used construct conceptualizations and scales. In general, we found that research on business relationships yields relatively few insights for our study in that respect. First, regarding the construct of cooperation, Anderson et al. (1994) summarized: "Surprisingly, cooperation seldom has been studied explicitly as a construct." Second, to model the outcome of a relationship, studies in relationship marketing often use constructs such as trust (e.g., Kumar, Scheer, and Steenkamp, 1995), commitment (e.g., Kumar et al., 1995; Mohr, Fisher, and Nevin, 1996), and satisfaction (e.g., Bejou, Wray, and Ingram, 1996; Mohr et al., 1996; Mohr and Spekman, 1996). These constructs are useful within the context of the more general discussion of relationship marketing or distribution channels. They do not seem to be appropriate for our own study because it focuses on a single new product (project) as opposed to a focus on relationships in relationship marketing. We will therefore use some more specific measures of success explicitly related to new product development.

In summary, studies in relationship marketing highlight the importance of information exchange and cooperation between business partners. These studies provide theoretical and empirical evidence that certain types of cooperation have a positive impact on performance thus supporting the plausibility of our fundamental tenet. Work in this area also reveals that cooperation outcomes may depend on partner attributes. More specifically, research in this area suggests that characteristics such as the partner's reputation are relevant when choosing cooperation partners. Although relationship marketing thus yields useful insights into the area of our study, its contribution to understanding new product development performance is limited in two ways. First, researchers in the field of relationship marketing have typically investigated cooperation at a very general level. Second, success measures used in relationship marketing research are not appropriate for the specific context of new product development.

Studies of New Product Success

Within the new product development literature, there are a number of studies that seek to identify the factors that determine the outcome of new product development. Generally, a distinction can be made between "generalist" and "specialist"

studies. Generalist studies typically include a broad range of possible determinants of new product success and aim at identifying the most important ones among them within an exploratory research design. On the other hand, specialist studies focus on an in-depth analysis of a limited range of determinants of new product success.

Well-known generalist studies (see, e.g., Montoya-Weiss and Calantone, 1994; Lilien and Yoon, 1989 for overviews) include project SAPPHO (Rothwell et al., 1974), project NewProd I (e.g., Calantone and Cooper, 1981; Cooper, 1979a, 1979b, 1982), and project NewProd II (e.g., Cooper and Kleinschmidt, 1987). Because of their very broad research design, many of the generalist studies did not include the aspect of customer interaction as a possible success factor. The studies that did include this construct, came to some interesting findings. As an example, the classic SAPPHO-project (Rothwell et al., 1974) led to the following conclusion:

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. Many successful firms achieve this deep and imaginative understanding of user needs through interaction with a representative sample of potential customers throughout the development (Rothwell et al., 1974, p. 289, original italics).

It has to be mentioned however, that this statement is based primarily on the performance impact of meeting user needs. A significant difference between successful and unsuccessful products with respect to the item "customers involved at development stage" could only be found for scientific instruments ($n = 21$, Rothwell et al., 1974, p. 278).

Maidique and Zirger (1985, p. 303) came to a similar finding and summarized: "As a rule, the development process for the successful products was characterized by frequent and in-depth customer interaction at all levels and throughout the development and launch process." These statements are based on the findings of case studies that were carried out for 40 products. Cooper (1979b, p. 131) included a stage-specific aspect of customer interaction ("prototype testing with customers") in his research design and found that this activity was positively related to new product success.

Among the specialist studies, very few investigated the interaction with customers in the new product development process. Notable exceptions are the studies of Biemans (1991), Parkinson (1981, 1982, 1985) and Shaw (1985). Biemans (1991) investigated the level of customer interaction in the Dutch medical equipment industry ($n = 17$ projects), but did not analyze any performance implications. Parkinson (1982) used a particular research design measuring customer interaction from the perspective of the customer. From the analysis of 16 British and German machine tool manufacturers and 129 of their customers, he concluded that a higher level of customer interaction in Germany and the more demanding, more innovative customers in Germany determine the higher

success of the German machine tool industry. Thus, the importance of the characteristics of the involved customers is emphasized. Shaw (1985) found in an analysis of 34 projects in the British medical equipment industry that customer interaction is associated with new product success. In Gemünden, Heydebreck, and Herden's (1992, p. 367) study focusing on innovation in networks, nearly 50% of the firms claimed "that the contact with the customer had been a precondition for innovation success." Research by Gemünden, Ritter, and Heydebreck (1996) shows that innovation success is significantly correlated with a firm's "technological network" which consists of relationships with customers and suppliers, among others. To the best of our knowledge, no study has investigated the performance impact of interaction with customers in the different stages of new product development.

The literature review on studies of new product success reveals three findings. First, some of the generalist studies identified intensive communication with the customer as a determinant of new product success. However, because of their broad perspective, these studies provide only limited insight into the interaction with customers. Specifically, the interaction is neither differentiated with respect to different stages of the new product development process nor are customer characteristics investigated. Second, there exist only very few specialist studies examining customer interaction. The few existing studies typically provide only descriptive data on the performance implications of customer interaction. Third, most of the studies use single-item measures for new product success. Measurement reliability and validity are typically neglected issues. This is particularly critical as new product success has been shown to be a complex construct (Griffin and Page, 1996).

Lead User Analysis

Von Hippel (1976), introducing the customer active paradigm (CAP), states that under certain circumstances, the customer would start innovating himself when encountering a problem. As a first step, customers generate ideas on how to solve the problem. Arguing further, von Hippel (1976, 1978) suggests that customers should be even more "active," conduct the problem solving, and develop working prototypes. This was referred to as the customer active paradigm (CAP) as opposed to the traditional manufacturer active paradigm (MAP), where the manufacturer generates new product ideas, and conducts all the problem solving (von Hippel, 1978). The key difference between the two paradigms lies in the role that the customer plays during new product development (von Hippel, 1980). The CAP was later extended to an interaction perspective, called the lead user concept. It suggests a cooperation with certain customers for new product development. Those customers are characterized by two attributes:

Lead users face needs that will be general in a marketplace—but face them months or years before the bulk

of that marketplace encounters them, *and* lead users are positioned to benefit significantly by obtaining a solution to those needs (von Hippel, 1988, p. 107, original italics).

Although von Hippel (1986) argues that new product success can be increased using this method, larger empirical studies would add to these case study findings (e.g., Urban and von Hippel, 1988; von Hippel, 1988).

In summary, the lead user concept provides further evidence that interacting with customers may contribute to new product success. Also, it underlines the importance of choosing customers with specific attributes (vs. a random sample) for cooperation.

The Study

Purpose and Scope

The literature review unveils a research deficit regarding customer interaction as a means to improve new product success. Previous studies provided mainly descriptive data on the performance implications of customer interaction in the new product development process. Stage-specific aspects of customer interaction and customer characteristics have been neglected so far. Additionally, reliable and valid measurement of complex constructs such as new product success has not been a primary concern in research on new product development. Against this background, the purpose of our study is to extend previous studies in essentially three ways. First, we seek a deeper understanding of the performance implications of customer interaction in the context of the new product development process. Specifically, we will investigate the performance impact of both the intensity of customer interaction in different stages of new product development and the characteristics of the involved customers. Second, to allow sound statistical tests of the performance implications, we conduct a large-scale empirical study. Third, we will apply multi-item scales to measure the different multifaceted constructs such as new product success with specific concerns for validity and reliability.

Our study thus deals with the following two basic propositions.

- P1: The intensity of customer interaction in the new product development process has a positive impact on new product success which, however, varies by process stage.
- P2: The characteristics of the involved customers have an impact on new product success.

As has been discussed before, a theoretical justification for a positive influence of customer interaction on new product success can be obtained from resource dependence theory (Pfeffer and Salancik, 1978). The hypothesis of differential effects by stages of the new product development process is in line with the high importance of the process perspective

in new product development (Saren, 1994). More specifically, authors have emphasized the different nature of tasks to be performed at different stages of the new product development process (e.g., Crawford, 1994). As an example, the research by Ancona and Caldwell (1990) suggests that the level of boundary management activities in product development teams varies by phase of the project. Clearly, interaction with customers can be interpreted as a boundary management activity. Moreover, the classical work by Burns and Stalker (1961) suggests that different organizational forms may be optimal in different stages of the innovation process. It is therefore reasonable to assume that the appropriateness of customer interaction also varies by process stage. The second proposition is justified by the work by von Hippel (1988) as well as work in relationship marketing suggesting that intensive interaction between business partners may not always be beneficial (Heide and John, 1990). Rather, partner attributes tend to have an impact on cooperative outcomes (Ganesan, 1994; Doney and Cannon, 1997). With respect to customer characteristics we focus on characteristics suggested in the relationship marketing literature (e.g., reputation; see Doney and Cannon, 1997) and the lead user characteristics suggested by von Hippel (1988).

Our unit of analysis is the new product that has been introduced into the market as well as the corresponding development process. The scope of our study is limited in three respects including the type of product, the degree of innovation, and the degree of customization of the product.

First, the new product development process varies greatly between consumer products and industrial goods (Biemans, 1991). In the industrial goods sector, customers typically have a higher level of expertise regarding the product compared to those in consumer goods markets. Our study therefore deals with industrial marketing settings.

Second, studies in the field of new product development emphasize the importance of the degree of innovation for research concerning new products (Heany, 1986; Kleinschmidt and Cooper, 1991). Minor design changes and basic innovations are excluded from the study. Minor design changes are not considered because respondents may not recall exactly the events during the development of those relatively unimportant products (von Hippel, 1976). Basic innovations are excluded because privacy of information is a major issue in the development of breakthrough new products. This induces reluctance in the contact with external partners. Additionally, because basic innovations yield some completely new features, customers cannot provide any user experience with those radically new products. Thus, the study concentrates on mid-range innovations.

Third, interaction with customers during the development process of customized products poses very specific problems. For instance, the identification of the most preferable interaction partner is not relevant in this context. Another key issue is that customized products cannot be developed without

a significant amount of customer interaction which makes performance impacts of customer interaction almost a tautology in this context. We therefore restrict our study to products developed for a broad market thus excluding customized products.

Because product development processes differ even within industrial goods markets from industry to industry, we focus on a single industry. For our field research and the data collection we chose the German machinery industry for two reasons. First, according to statistics of the applications for patents, this industry is very innovative (Deutsches Patentamt, 1989). Second, the machinery industry is a large industry in Germany. These two facts assure the existence of a sufficient number of development projects as a basis for the survey research.

Preliminary Field Research and Conceptual Framework

The research presented in this article is based on inductive field research followed by a survey. The field research consisted of personal interviews with a dozen managers in the German machinery industry. The semi-structured interviews typically lasted about an hour in length and were audiotaped unless the interviewee requested otherwise. Interview partners included vice presidents in charge of R&D and marketing vice presidents.

Besides seeking a better understanding of the phenomenon of customer interaction in new product development, in general, we had three specific objectives for the field interviews. First, multi-item measures for the relevant constructs were drawn from the existing literature in new product development research, marketing, and related disciplines. We supplemented these measures with findings from interviews. Second, a stage model had to be developed that represents the typical new product development process in the industry under consideration. Third, the final objective was the identification of the suitable respondent in the company for our survey.

With respect to the first specific objective, measures had to be developed for the intensity of customer interaction in the different stages of the new product development process, for the customer characteristics, and for new product success.

To assess the intensity of customer interaction in different stages we developed a scale that is applicable in all stages of the development process. This allows for comparisons of intensity across different stages. We had to develop our own scale because this specific construct has so far only been measured using a single-item measure or associating the form of the interaction with intensity of interaction (e.g., Ives and Olson 1984). A large number of insights with respect to the facets of intensity of interaction emerged from the interviews. The answers converged to six items that are described in the section on measure development and validation.

While some characteristics of the involved customers are suggested by the literature, no integrative conceptualization

of the underlying dimensions could be drawn from literature. The interviews thus served to identify the basic customer characteristics and generate corresponding items. We identified four different types of customer characteristics. First, technically attractive customers are very innovative and have a strong know-how basis. Second, customers' financial attractiveness relates to their representativity of the target market and their reputation within that market (Ganesan, 1994). The third characteristic is the closeness of the relationship between the focal company and the customer. This includes the level of interaction outside the respective innovation project and the duration of the business relationship (Doney and Cannon, 1997). Finally, the lead user characteristics suggested by von Hippel (1986) were considered as relevant by the interviewees.

By now, the multidimensionality of the construct of new product success has been accepted (Griffin and Page, 1996). In accordance with Clark and Fujimoto (1991), Crawford (1994), and Olson, Walker, and Ruekert (1995), we chose three dimensions including quality of the new product, financial new product success, and quality of the new product development process. These dimensions were supported in the interviews from which the items were generated. As some firms also mentioned the inexpensiveness of new product ownership as an important dimension of new product success, we included this additional dimension. As an example, one marketing vice president stated:

Those three dimensions [quality of the new product, financial new product success, and quality of the new product development process] are very common and typical for looking at new product success. What most companies neglect is the inexpensiveness of new product ownership. This is an aspect that has come to paramount importance to our customers because price pressure on them is tremendous. We should not overlook this aspect. If it is important for our customers, it must be important for our products.

Remember that the second specific objective of the field interviews was the development of a stage model that is appropriate for the new product development process in the industry under consideration. A wide variety of stage models are discussed in the relevant literature (Saren, 1994, for an overview see More, 1986). Cooper and Kleinschmidt (1986) developed a stage model containing 13 stages. In an empirical study, only six of the 13 stages could be identified in more than two thirds of the sampled companies. Those stages were initial screening, preliminary market assessment, preliminary technical assessment, product development, in-house product testing, and market launch. Based on this result and the work of Myers and Marquis (1969) and Crawford (1994), a six-stage model was developed and validated in the interviews. The stages include idea generation, product concept development, project definition, engineering, prototype testing, and market launch.

The final research question in the interviews was the identification of the most knowledgeable categories of informants.

Possible addressees include both the R&D vice president and the marketing vice president. The R&D vice president turned out to be the superior informant for our study as he typically has a better overview of the complete new product development process including new product success. Alternatively, marketing vice presidents were primarily well informed about the late phases of new product development when the new product was launched into the market, but not about earlier stages.

In summary, the framework of our study links the intensity of customer interaction during the new product development process and the characteristics of the involved customers to new product success (see Figure 1). Customer interaction is measured in six stages of the new product development process. Customer characteristics include the lead user characteristics identified by von Hippel (1986) and the other three dimensions that were identified in the interviews. New product success is conceptualized as a four-dimensional construct.

The Sample

After the field interviews, a survey was conducted to answer the research questions. The survey focused on firms with at least 250 employees. The interviews had shown that a minimum firm size is necessary to assure an established new product development process in the company. The respondents were essentially free in choosing the new product they reported on. However, they were asked to pick a product that met the following conditions: (1) the product represents a mid-range innovation (as discussed before); (2) the success of the chosen new product can already be estimated; (3) the respondent is knowledgeable about this product's success with respect to the success dimensions included in the framework; and (4) the respondent has a deep understanding of the development process for this specific new product from idea generation to market launch.

Addresses from companies in our target group were obtained from the German Chamber of Industry and Commerce (IHK). Questionnaires were mailed to 1,229 vice presidents of R&D in these companies. As an incentive for filling out and returning the questionnaire, respondents were promised a report summarizing the major findings of the study. Ten questionnaires were undeliverable, resulting in 1,219 surveys delivered to the addressees.

A reminder with a replacement questionnaire was mailed out to nonrespondents at the end of the third week after the initial mailing (171 questionnaires were obtained at this point of time). This procedure yielded a response rate of 25.6% (314 respondents). Three hundred ten responses were usable for a final response rate of 25.4%.¹ The average total revenue

¹ To test for possible nonresponse bias, we used two approaches (Armstrong and Overton, 1977). First, we performed chi-square comparisons of the respondents and nonrespondents with respect to firm size (number of employees and total revenue). These analyses indicated that respondents and nonrespondents were homogeneous regarding these variables. Second, we made a comparison of early and late respondents (first 3rd vs. last 3rd) with respect

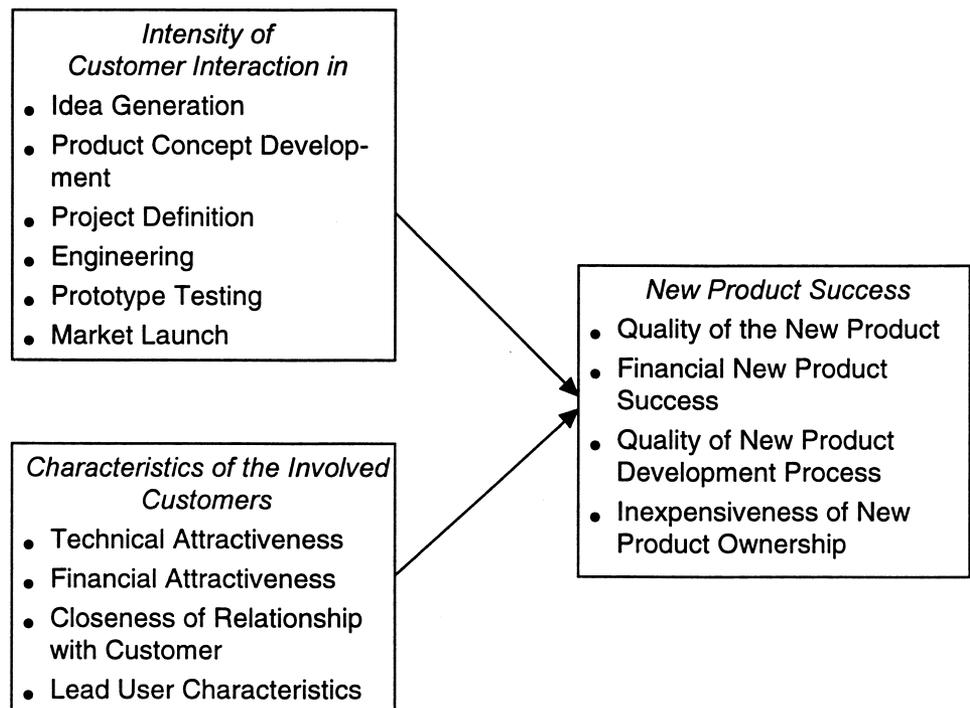


Figure 1. Conceptual framework.

of the firms in the sample was DM 372 m (1.5 DM was approximately equivalent to US \$1 at the time of the survey) and the number of employees averaged 1,019.

Measure Development and Validation

Scales for the study consisted of newly generated items and items that had been previously utilized in the literature. When a new scale was developed, guidance was obtained from field interviews and by construct definitions utilized in marketing and research on new product development. All measures were conducted with a 7-point Likert scale (“strongly agree” and “strongly disagree” as anchors).

For measure validation, we used conventional methods such as coefficient alpha, item-to-total correlations, and exploratory factor analysis (Churchill, 1979), as well as the more advanced approach of confirmatory factor analysis. It is widely accepted that confirmatory factor analysis is superior to conventional approaches in several respects (Bagozzi, Yi, and Phillips, 1991; Gerbing and Anderson, 1988). Regarding the threshold values of the criteria we followed the suggestions of Bagozzi et al. (1991) and Bagozzi and Yi (1988). For parameter estimation we used the weighted least squares (WLS) method in LISREL 8 (Jöreskog and Sörbom, 1993). This method yields asymptotically efficient parameter estimates under very general distributional assumptions.

INTENSITY OF CUSTOMER INTERACTION. For each of the stages of our product development model, we used six items to

measure the intensity of customer interaction. Confirmatory factor analyses for the scale were conducted separately for each stage of the new product development process. Table 1 describes the items and the results of reliability and validity assessment.

As suggested by these values, the items and scales demonstrate reasonable reliability and validity in all six stages. All coefficient alphas exceed Nunnally’s (1978, p. 274) 0.7 threshold value. Composite reliabilities exceed 0.9 and average variances extracted are above 0.7, exceeding the generally acceptable cut-off levels of 0.7 and 0.5, respectively (Bagozzi and Yi, 1988). Overall, our conceptualization of the constructs was supported empirically.

CUSTOMER CHARACTERISTICS. The measurement of customer characteristics referred to the lead user concept and the three other dimensions identified in the interviews. In accordance with von Hippel’s (1986) definition of lead users, two items were generated for the lead user concept. They were multiplied to form the lead user characteristics measure (representing the “and” condition of von Hippel). For the other three dimensions of the customer characteristics two items each were generated in the interviews. The reliability of the three dimensions of customer characteristics is acceptable.² Results are summarized in Table 2.³

² Confirmatory factor analyses could not be performed due to the minimum number of three items.

³ It is worth mentioning that the value of the coefficient alpha depends on the average inter-item correlation and the number of items in the scale. For example, Carmines and Zeller (1979) calculate that, for a scale with an inter-item correlation of 0.40, coefficient alpha equals 0.572 for a scale with

to firm size, all variables regarding customer interaction and variables indicating new product development success revealed no significant differences.

Table 1. Results of the Measure Validation for the Intensity of Customer Interaction

Factor	Items	Coefficient Alpha	Composite Reliability	Average Variance Extracted
Intensity of Customer Interaction in				
Idea Generation	<ol style="list-style-type: none"> 1. We interacted with customers beyond the standards of market research 2. The duration of joint work was long 3. Frequency of meetings with customers was high 4. A high number of persons were involved from customer companies 5. The (perceived) intensity of customer interaction was high 6. The number of involved companies was high 	0.91	0.96	0.79
Product Concept Development	see above	0.91	0.95	0.76
Project Definition	see above	0.90	0.95	0.73
Engineering	see above	0.90	0.95	0.76
Prototype Testing	see above	0.91	0.95	0.76
Market Launch	see above	0.91	0.96	0.78

NEW PRODUCT SUCCESS. Our framework distinguishes four dimensions of new product success including the quality of the new product, financial new product success, the quality of the new product development process, and the inexpensiveness of new product ownership. For the first three dimensions, we utilized the work of Griffin and Page (1993) and Olson et al., (1995) supplemented by the work of Garvin (1984) for the measurement of the quality of the new product. To measure the inexpensiveness of new product ownership, we generated two items in the interviews. As suggested by the conceptual and empirical work of Hart (1993), the measurement of the items was indirect in almost all cases (i.e., the respondents indicated performance in comparison to their expectations, compared to competitors or technically similar products). The coefficient alphas are all above 0.7 thus exceeding the threshold value. Composite reliabilities and average variance extracted also exceed the respective threshold values. Overall, the data shows satisfactory empirical support for our conceptualization of the constructs. The results are shown in Table 3.

Results

Performance-Based Typology of New Product Projects

After measure validation, the relationship between (1) the intensity of customer interaction and (2) the characteristics

two items. An increase in the number of items from 2 to 4, all other things being equal, would result in an increase of coefficient alpha to 0.727. Considering this effect, the two-item scale representing a coefficient alpha of 0.54 is acceptable (see Carmines and Zeller, 1979, p. 46).

of the involved customers and new product success had to be determined. Prior to this, cluster analyses based on the four dimensions of new product success were performed to reduce complexity regarding the dependent variables.⁴ Following the suggestions of Milligan and Cooper (1987) and Punj and Stewart (1983), first a single-linkage clustering algorithm was performed to identify outliers. After eliminating 23 outliers, Ward's method led to the identification of four clusters based on the elbow-criterion. The centroids of this solution were used as the starting solution for the K-means algorithm that led to the final clustering results. Descriptive information regarding the four clusters is displayed in Table 4.

The four clusters are clearly distinct and can be meaningfully interpreted. We label cluster 1 as "top projects" because

⁴ It is worth mentioning that in addition to the results shown in Table 3 we also assessed discriminant validity between the different dimensions of new product success. This was done using two procedures. First, one-at-a-time, chi-square difference tests between a model where a factor correlation parameter is fixed at 1.0 and the original (unrestricted) four-factor model were performed. As every restricted model exhibited a significantly poorer fit than the unrestricted model, with even the smallest increase in chi square being highly significant ($p < .001$), we conclude that there is a sufficient degree of discriminant validity between the four factors. However, a more stringent procedure for assessing discriminant validity has been suggested by Fornell and Larcker (1981). These authors suggested that the average variance extracted for each factor should be larger than the squared correlation coefficient between this factor and any other factor in the model. This was the case for all new product success dimensions. Discriminant validity is therefore evident. Thus, using an overall measure of new product performance by aggregating across dimensions (e.g., by averaging across the indicators) is not a viable approach. On the other hand, assessing the performance impact of customer interaction with respect to all four success dimensions separately would yield very complex results. Thus, cluster analyses were performed to reduce complexity.

Table 2. Results of the Measure Validation for the Customer Characteristics*

Factor	Content of Items	Coefficient Alpha
Technical Attractiveness	Customers' innovativeness	0.74
Financial Attractiveness	Customers' know-how	0.74
	Representativeness of customers for target market segment	
Closeness of Relationship with Customer	Customers' reputation in the market	0.54
	Frequency of interaction with customers outside new product development project	
Lead User Characteristics	Duration of business relationship with customers	n.a.*
	Customers' benefit from the solution provided by the new product	
	Customers' recency in the need for the new product	

* The two items for the lead user characteristics are combined in a multiplicative way, thus coefficient alpha is not applicable.

the projects in this cluster are superior on average to the other three clusters in all performance dimensions. Cluster 2 is named "flop projects" because the projects in this cluster are inferior to all other clusters in three out of four performance dimensions. Cluster 3 and cluster 4 yield medium results in

the first three performance dimensions. They differ from the average mainly regarding the performance dimension of inexpensiveness of new product ownership. Thus, cluster 3 can be labeled "cost saving projects" and cluster 4 "cost driver projects."

Table 3. Results of the Measure Validation for the New Product Success Measures

Factor	Items	Coefficient Alpha	Composite Reliability	Average Variance Extracted
Quality of the New Product	Technical capabilities of product (relative to technically similar, self-developed products)	0.76	0.90	0.61
	Technical capabilities of product (relative to competition)			
	Technical features (relative to competition)			
	Conformance to customer requirements			
Financial New Product Success	Aesthetics	0.88	0.90	0.75
	Customer satisfaction with quality			
	Achievement of profit goals			
Quality of the New Product Development Process	Achievement of project break-even time goal	0.73	0.90	0.65
	Satisfaction with financial success			
	Duration of development (relative to project size, reverse scored)			
	Timeliness of market launch			
	Satisfaction with the development process			
Inexpensiveness of New Product Ownership	Inexpensiveness of project (relative to size)	0.80	-	-
	Use of manpower (relative to size, reversed item)			
	Operating costs for customers			
	Customer's ability to reduce prices for his own products			

Table 4. Clusters Based on New Product Development Success

Cluster	Number <i>n</i>	Quality of the New Product		Financial New Product Success		Quality of the New Product Development Process		Inexpensiveness of New Product Ownership	
		Scale Mean	Std. dev.	Scale Mean	Std. dev.	Scale Mean	Std. dev.	Scale Mean	Std. dev.
1: Top Projects	66	6.46	0.43	6.14	0.63	5.71	0.56	6.16	0.90
2: Flop Projects	51	5.73	0.70	3.77	0.75	2.98	0.73	5.75	0.87
3: Cost Saving Projects	78	6.10	0.48	5.13	0.79	4.47	0.70	5.81	0.77
4: Cost Driving Projects	41	5.95	0.60	4.32	0.91	4.12	0.91	3.18	1.00

1 = not successful, 7 = very successful.

Performance Implications of Customer Interaction

For further analyses, only clusters 1 and 2 will be used. Thus, discriminant analyses will be performed with the clusters “top projects” and “flop projects” as dependent variables.

INTENSITY OF CUSTOMER INTERACTION. Discriminant analysis was performed to assess the impact of the intensity of customer interaction in the six new product development stages on new product success. The results can be seen in the upper part of Table 5. Wilk’s lambda is 0.893. The number of correctly classified cases is 64.2%. The significance of this predictive accuracy can be assessed by comparing this percentage to the proportional chance criterion (see Morrison, 1969). The proportional chance criterion is 50.95% in this case. The improvement in predictive accuracy to 64.2% represents a 26% information gain, which exceeds the required value of 25% suggested by Hair et al. (1979) for a meaningful discriminant analysis. Thus, the results indicate that the predictor variables discriminate between “top” and “flop” projects to a

satisfactory extent. It has to be acknowledged, however, that the predictive accuracy is not very high. If the multiple factors influencing new product success are taken into consideration (e.g., economic factors, competitive reactions, or marketing activities for the new product), the relatively weak effect comes at no surprise and is consistent with conceptual reasoning.

We now look at the individual discriminant coefficients shown in Table 5. The intensity of customer interaction in the first two stages of the new product development process yields significant (at least on the 0.1 level) effects on new product success. The positive effect of the interaction in the idea generation is weaker compared to the product concept development stage. This provides some evidence that customer information is more valuable in the more concrete stage of concept development. The project definition and engineering stages yield non-significant results. This finding is consistent with a statement by Cooper (1993, p. 52) that “competence in the technological tasks in the project” is a main success factor in new product development. Thus, during the technical development, companies should rely on their own

Table 5. Results of the Discriminant Analyses

Independent Variables	Standardized Discriminant Function Coefficients	F-value
Intensity of Customer Interaction in . . .		
Idea Generation	0.243	3.593*
Product Concept Development	0.592	4.422**
Project Definition	−0.073	1.316
Engineering	−0.730	0.043
Prototype Testing	0.630	4.216**
Market Launch	0.239	4.665**
Characteristics of the Involved Customers		
Financial Attractiveness	0.536	5.968**
Technical Attractiveness	−0.255	2.534
Closeness of Relationship with Customer	0.469	4.845**
Lead User Characteristics	0.515	4.643**

* $p \leq 0.10$.

** $p \leq 0.05$.

skills and should not expect technical solutions from customers. The intensity of customer interaction in the last two stages (prototype testing and market launch) yields significant, positive discriminant coefficients. Customer interaction in the prototype testing stage displays the largest significant effect of all stages. An explanation can be that (1) in this stage the possibility to adapt the product design to customer requirements still exists and (2) customers are able to provide very detailed and precise information regarding an existing and working prototype. The benefits of interacting with customers during the market launch are restricted to insights in the positioning of the new product, or the opportunity to use some customers as a reference. Product changes are no longer possible at this stage. Thus, it is not surprising that the discriminant coefficient of customer interaction in this stage is the smallest of all significant effects.

In summary, we find support for P1. Our findings show that the intensity of customer interaction in the product development process, indeed, is positively associated with new product success. Additionally, this effect varies by process stage. More specifically, customer interaction during early and late stages of the new product development process can increase new product success, whereas interaction during the medium stages yields no performance impact.

CHARACTERISTICS OF THE INVOLVED CUSTOMERS. A second discriminant analysis was conducted to assess the impact of the characteristics of the involved customers on new product success (P2). The results of this analysis are shown in the lower part of Table 5. Wilk's lambda is 0.923, the number of correctly classified cases is 64.6%, which represents a 27% increase over the proportional chance criterion of 51%. Similar to the intensity of customer interaction, the results are satisfactory but not very strong.

The lead user concept is supported as the interaction with customers featuring lead user characteristics yields a positive discriminant coefficient. Also, financially attractive customers seem to be valuable cooperation partners as they display the largest (positive) discriminant coefficient. Close customers yield positive results, too. It is likely that companies are able to share private information with those customers and that they can trust them which may be expected to enhance the effectiveness of the cooperation. A possible explanation for the negative performance impact of technically attractive customers is that they may have needs that are different from those of the market in general. Thus, the interaction with technically attractive customers can mislead the innovating firm. Another possible explanation for this effect is based on the concept of core competence. It could be argued that firms involve technically competent customers when they have difficulties solving the technical problem on their own. Interestingly, this result corresponds with the findings related to customer interaction during new product development. In that analysis, we found a nonsignificant impact of customer

interaction in the stages where a technical solution has to be developed.

In summary, we found that (as hypothesized in P2) the characteristics of the involved customer impact on new product success. The selection of the cooperation partners has to be made consciously and carefully. Lead users, financially attractive customers, and close customers are attractive interaction partners.

State of Practice

After assessing the performance impact of the intensity of the customer interaction during new product development we were interested in the state of practice in this field. The arising question is: To what extent do firms interact with customers in the different stages of the product development process? The following intensities of customer interaction were computed: 2.42 in the idea generation, 2.58 for the product concept development, 2.76 in the project definition stage, 2.42 in the engineering stage, 3.38 in the prototype testing stage, and 4.14 in the market launch stage (7-point Likert scale, 1 represents no interaction, 7 equals maximum interaction). These findings indicate that companies can improve their customer interaction and thus increase new product success. In the first four stages of the new product development process, the companies interact with their customers only to a minimum extent. In particular, the very low interaction in the first two stages comes as a surprise because for those stages we could detect a significant positive performance impact of customer interaction. Except for the engineering stage, a consistently increasing level of customer interaction along the new product development process can be found. Even in the prototype stage, the average intensity of customer interaction is below 4. This does not reflect the positive impact of customer interaction in this stage, where we could detect the largest (significant) discriminant coefficient. Only in the last stage of the new product development process does the intensity of interaction exceed the center of the scale.

In general, we find that the state of practice does not correspond to the performance implications of customer interaction. This is particularly true for the early stages of the new product development process. There seems to be a tendency to stay away from the market in those stages. We conclude that companies could improve their new product development process significantly by taking into consideration the findings concerning the positive performance implications of increased customer interaction.

Discussion

Research-Related Implications

Our study uses resource dependence theory (Pfeffer and Salancik, 1978) as the theoretical background. On a general level, our findings provide support for the basic tenet of resource dependence theory that bridging between organizations can

enhance organizational effectiveness. This illustrates the adequacy of this theoretical perspective for studying interorganizational relations in marketing.

While existing literature concerning the performance implications of customer interaction in new product development provides some general statements, our study yields more specific insights in two ways. First, customer interaction during early and late stages of the new product development process can increase new product success. Interaction during the medium stages yields no performance impact. Second, the selection of the interaction partner should be based on specific characteristics. We could find support for the lead user concept of von Hippel (1986). Financially attractive customers and close customers yield similar positive results, whereas technically attractive customers do not have a positive impact on new product success.

Our study also has implications for the field of relationship marketing. First, it is important to note that (as Heide and John, 1990, have pointed out) bilateral governance is not universally desirable. Specifically, our study indicates that timing as well as selection of partners are critical in interacting with customers. It is reasonable to assume that this phenomenon is not restricted to the context of new product development. Therefore, future research in relationship marketing can benefit from including dynamic aspects as well as issues related to partner characteristics in the research design. Also, some of the empirical research in relationship marketing suffers from the fact that performance implications of close relationships are difficult to demonstrate. Even the definition of success in relationship marketing is a problem. As Mohr and Spekman (1996, p. 39) put it: "The definition of partnership success is, to a certain degree, nebulous." One possible explanation for this phenomenon is that studies in relationship marketing typically have a very general perspective in which it is difficult to assess performance on an empirical basis (a notable exception is the study of Kalwani and Narayandas, 1995, in which the ROI is used as a performance measure). It is promising to look at customer interaction in a more specific context and use more specific and tangible performance measures as our study has done for the context of new product development.

Typically, empirical research in the area of new product development has drawn on very simple and mostly single-item measures. We view our study as a contribution to scale development in this field of research as it illustrates how advanced techniques of measurement development and validation can be used for this purpose. For the measurement of new product success, a four-dimensional model was identified and tested with confirmatory factor analyses. Satisfactory results could be obtained. This measurement model could be helpful for future studies, as it incorporates and extends the findings of many previous studies. Also, the stage-specific measurement model for the intensity of customer interaction during new product development identified and validated in this article has potential applications in future research.

Managerial Implications

There are a number of important implications for marketing and new product development professionals in industrial markets. Most important, we could support our fundamental hypothesis that customer interaction in new product development has a positive impact on new product success. Additionally, our study provides specific insights in which stages customers should be involved and we provide guidance on which customers to select for cooperation.

The results encourage firms to interact with customers specifically in early and in late stages of the new product development process. A deficit in current business practice is particularly evident in the early stages. The study found no benefits in interacting in the two medium stages. Nevertheless it might be useful to stay in contact with customers during the medium stages and keep them informed on the progress of the new product development process so that customers can more easily be involved again in the late stages of the project. Regarding the collaboration partner, the selection should be made very carefully and consciously. The interaction with lead users or financially attractive customers is most promising. On the other hand, technically attractive customers do not promote new product success.

Limitations and Future Research

In spite of the great care taken at every stage of this research, there are several limitations to our study. First, by choosing to focus on a limited set of new products, the results by necessity do not consider new products with other characteristics. The results can only be applied to not customized new products with a mid-range degree of innovativeness.

Second, the sample is industry-specific and extensions to other industries must be made carefully. An area for future research is the replication of the study in other industry settings, although consumer goods pose a different problem than industrial goods. Third, our analysis has been restricted to a national context. Although in the design of the study no aspects were incorporated that are specific to Germany, an international replication study could yield interesting results.

In our study we did not address the content of the information that is transferred in the customer-supplier interaction. Future research could assess the relationship between the content of the transferred information and new product success.

Generally, customers are just one group of many possible external partners for a firm. Specifically, vertical cooperations, strategic alliances, or joint ventures could be formed to jointly develop products. This aspect is discussed in studies regarding single-sourcing (e.g., Turnbull, Oliver, and Wilkinson, 1992) and just-in-time (e.g., Frazier, Spekman, and O'Neal, 1988). While investigating the interaction with customers was based on the importance of information on customer needs and user experience for new product development, the performance implications of interaction with other groups are also critical.

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