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NEW PRODUCT PRACTICES AND PERFORMANCE OF GERMAN APPLIANCES COMPANIES

An efficient new product strategy for German industry of household appliances, requires being first in the market. Concept testing, concept screening, marketing plan development and market introduction are new product process activities which have a positive impact on new product performance in the industry. Also applying project matrix and outsourcing prototyping or tooling are an effective means of new product development for German producers of household appliances.

Keywords: new product development, product performance

INTRODUCTION

The stream of studies on determinants of new product performance have an important place in the area of new product development (NPD) because they aim to find factors or managerial practices that are likely to influence new product outcomes. These studies allow the determination of a set of NPD "best practices" which can be applied by new product managers to achieve better results. This situation means that a lot of studies have been carried out to find new product performance determinants, for example Montoya-Weiss and Calatone (1994) identified forty-seven different empirical studies of this type. However, these studies differ in several ways and the main dissimilarities are as follows: range of factors investigated, country considered, type of organization or goods studied, and methodology used. By analyzing differences between research carried out on determinants of NPD performance, Montoya-Weiss and Calatone (1994) pointed out several needs and implications for future research. This study tries to reply to some of them.

In this study we take a contingency approach because we focus on a specific industry, the appliance industry, in one particular country, Germany. Our attitude is supported by the results of meta-analysis conducted by Henard and Szymanski (2001), who showed that NPD performance can vary

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by contextual factors such as geographic region and nature of the market. Therefore, having a particular region and a specific industry, we are going to make a contribution to the theory on determinants of new product performance.

We researched German firms as sales of new products in Germany are higher than average in Europe (European… 2001). In this way the research provides results from a country which has one of the leading economies in Europe and it responds to "an overrepresentation of Canadian firms in the empirical literature" (Montoya-Weiss and Calatone, 1994, p. 413).

We concentrate on a single industry to eliminate possible inter-industry effects on NPD. The results of such study are not valuable in generalizing across multiple industries but they enhance our knowledge about a specific industry. On the other hand, cross-industry studies are prone to generalizations, but their findings may be inappropriate for a specific industry. So far most studies on determinants of NPD performance were conducted across multiple industries (e.g. Cooper Kleinschmidt 2000; Cooper et al. 2004a; Dwyer and Mellor 1991; Gerstenfeld 1976; Gonzalez and Palacios 2002; Griffin 1997; Haffer 1998, p. 127; Larson and Gobeli 1980; Roper 1997). Single industry studies are still rare and examples of them are studies (Brockhoff and Chakrabarti 1988) and (Cooper and Kleinschmidt 1993), therefore we aim to fill this gap. We investigate domestic appliances companies, a medium high technology industry, as product life cycles in this industry are relatively short, and these goods are improved continually. The research takes a firm-level approach to study NPD versus project-level, so in this way it responds to the dominance of project-based studies in this field (Barczak 1995; Montoya-Weiss and Calatone 1994).

The scope of this research covers several aspects of NPD. We investigate factors coming from several following categories of NPD: strategy, process, organization, entrepreneurial climate, company commitment, and external links. These categories can be united under the theme of NPD management. Strategy, process and organization are cardinal issues of NPD and they were included in most studies on determinants of new product performance. On the other hand, such categories as climate, company commitment and external links have been less researched but new product performance predictors have already been identified for each of these categories (Cooper and Kleinschmidt 1995; Rothwell et al. 1974).

The research objectives of this study are as follows:

1. To what extent do German manufacturers of domestic appliances use NPD practices?

2. Which of the NPD practices are related to NPD performance in the case of German producers of domestic appliances?

To answer these questions we started with an exploratory study followed by the survey. Both stages are subsequently presented in this paper.

1. EXPLORATORY STUDY AND CONCEPTUAL FRAMEWORK

An exploratory study was undertaken to identify explanatory variables, according to the study scope, and new product performance measures. To carry out the exploratory study, we conducted a literature review followed by interviews with practitioners. Using the GBV direct database, the biggest German online library catalogue, we did the literature search. The interviews were carried out during the Domotechnica fair (Cologne, 2001) – one of the most important events in the domestic appliances industry – with experts from the organizations selected from the fair's Catalogue, from the class entitled *Industry Services*. These kinds of organizations were chosen because their representatives were less reluctant to take part in interviews than representatives of household producers, and still they were likely to posses knowledge about NPD in this industry. Altogether four in-depth interviews were performed with practitioners from the following organizations: 3D Systems, Division of Small and Large Domestic Electrical Appliances of German Electrical and Electronic Manufacturers' Association (ZVEI), VDE Testing and Certification Institute, Fraunhofer IMS.

The literature study provided information about potential determinants of NPD apart from external links. In the latter case the NPD literature was poor and the interviews helped to identify a subset of potential determinants of new product success or failure. Detailed outcomes of the exploratory study are presented below, and we supplement our literature findings with results from the interviews only in the case of external links, because in other cases (e.g. strategy, process, etc.) the interviews did not broaden the literature findings.

We start to present the outcomes of the exploratory study with a new product strategy. Cooper and Kleinschmidt (1995) stated that the second most important driver of NPD performance was "a clear and well-communicated new product strategy" (p. 389). In literature an attempt has been made to find the main components of the strategy. The most common components are objectives and strategic focus (Cooper 1987; Moore and Pessemier 1993, p. 130). Crawford (1980) also distinguished additional

elements of the strategy, namely background and guidelines. The latter can be determined in several ways, for example, by using a degree of product innovation or the timing of entry of a firm into the market.

There have been studies among German firms which paid attention to the strategic focus of a firm – on the market or on technology – (Brockhoff and Chakrabarti 1988; Gerstenfeld 1976; Roper 1997), but their results were not in agreement. Gerstenfeld (1976) stated that success was related to demand pull and failure related to technology push innovation projects. On the other hand, Brockhoff and Chakrabarti (1988) have found that among German firms technology push products were as likely to succeed as market pull products.

The previous research often explored new product timing strategies (see, for example Barczak 1995; Lambkin 1988; Robinson and Fornell 1985; Schnaars 1986; Urban et al. 1986). However, the results of these studies were not consistent. For example, Robinson and Fornell (1985) found that order of entry was a major determinant of market share, and pioneers gained a higher market share than later entrants. Urban et al. (1986) and Lambkin (1988) found similar results. On the other hand, Schnaars (1986) and Barczak (1995) concluded that no one timing strategy was better, so also later entrants – not only pioneers – could dominate the market.

Regarding the outcomes of the exploratory study on new product process we can say that the importance of applying a new product process has been underlined many times (see, for example Booz... 1982, p. 2; Cooper and Kleinschmidt 1995; Cooper et al. 2004c; Dwyer and mellor 1991; Griffin 1997; Sosnowska ed. 2003, p. 16 and 112). Presently, it is believed that by using the well-structured process we can achieve better new product results (Cooper et al. 2004c; Griffin 1997). Researchers try to identify activities that have a strong influence on high performance. For example, Barczak (1995) has found that in the telecommunication industry, idea generation and idea screening were related to high new product performance. Cooper and Kleinschmidt (1986) compared the frequency of undertaking activities of the new product process for successful projects versus unsuccessful ones. Their outcomes revealed that higher performance was related to nine out of thirteen researched process activities. Furthermore, Dwyer and Mellor (1991) have found that two activities: in-house product testing and production start-up, were undertaken significantly more often in successful than in unsuccessful projects. Therefore the prior research showed that some activities of the process were crucial to new product performance.

Now we move to findings of the exploratory study on new product structure. There are several organizational solutions that can be used for NPD (see, for example Barczak 1995; Crawford and Di Benedetto 2000, p. 284; Moore and Pessemier 1993, p. 111-112; Page 1993; Rutkowski 2006, p. 72; Souder 1987, p. 89-99). To classify them Crawford and Di Benedetto (2000) proposed to use a criterion *called the degree of projectization* (p. 284), and in a quite systematic way five different structures can be marked. They are as follows: functional (with or without committee), functional matrix, balanced matrix, project matrix, venture (ibid. p. 284; Larson and Gobeli 1980). If we combine three matrix solutions in one organizational arrangement, then we will have three NPD structures: functional organization, project matrix and venture organization (Moore and Pessemier 1993, p. 111).

Previous research examined the relationship between organizational NPD structures and performance. Barczak (1995) found that project teams and R&D teams were the most effective means for organizing NPD. This is in agreement with Griffin's results (Griffin 1997) who showed that best practice firms used multi-functional teams. Larson and Gobeli (1980) found that the most successful new products were developed when using venture team and project matrix. The authors also discovered that a product champion was a valuable means for NPD, and this is consistent with Barczak (1995).

With respect to entrepreneurial climate, our exploratory study shows that it is valuable for a firm to create a suitable climate for innovation to support it. Innovators to be creative need a certain margin of freedom. Literature describes several ways to encourage creativity within a firm, among others we can find such arrangements as *idea suggestion schemes*, *free time* or *skunk works* (Cooper and Kleinschmidt 1995; Crawford and Pessemier 2000, p. 35 and 72). By using these techniques a firm can create an entrepreneurial climate. Cooper and Kleinschmidt (1995) have found that an entrepreneurial climate for product innovation was one of the critical success factors in NPD. They underlined two features of this climate: *free time* and *skunk works*. To sum up, we limit our view of entrepreneurial climate to usage of special techniques – i.e. *idea suggestion schemes*, *free time* or *skunk works* - in a firm.

Regarding a company's commitment to NPD, our exploratory study indicates that this commitment can be expressed in a number of ways. However, two factors seem to be very important. The first is senior management commitment to product innovation, and the second the availability of resources needed for development. In several studies the

impact of senior management commitment on NPD was found to have a positive result (Booz … 1982, p. 7; Cooper and Kleinschmidt 1995; Gonzalez 2002). Additionally, Cooper and Kleinschmidt (1995) identified that the availability of adequate resources was a crucial factor for NPD success. In this situation we may focus on two variables to consider company commitment, i.e. senior management commitment and the availability of adequate resources, as these variables showed initial promise as antecedents of new product performance (Henard and Szymanski 2001).

Let us now turn to the outcomes of the exploratory study on external links. New product development studies have mainly taken into account internal factors, but external factors have been rarely taken into consideration. This fact has been underlined by Montoya-Weiss and Calatone (1994) who commented: "it is surprising that the impact of the general environment on new product performance has not been explicitly studied" (p. 412). Some external determinants of new product performance have already been identified in the SAPPHO project (Rothwell et al. 1974). Authors of this study have found that successful firms compared to unsuccessful ones had the following characteristics: they were better at coupling with the external scientific and technical community, they benefited from dependence on outside technology during production, and they had better external communication.

In the category of external links, the literature findings were supported by the outcomes of the interviews. The experts, who took part in our interviews, identified several external links used by German household appliance producers when developing new products. These links are as follows: outsourcing different services in several steps of NPD (e.g. using external designers, making prototype outside, outsourcing moulding tools), co-operation with Fraunhofer Society institutes which perform basic research in R&D activity, testing new products according to national and international standards and the participation in international projects (e.g. Framework Programmes). These links are consistent with findings of the SAPPHO project (Rothwell et al. 1974), hence they showed initial promise as determinants of new product performance. Therefore we may limit our view of external links to these variables. Also, they refer to German appliance industry and are actual factors.

Finally, we present findings of the exploratory study on measuring new product performance. Performance of NPD can be estimated using different measures. Griffin and Page (1993) who identified 75 measures of new product success and failure provided a broad list of NPD performance

measures. However, in practice this list is reduced to several characteristics (see, for example Barczak 1995; Cooper 1985; Cooper and Kleinschmidt 1995; Gonzalez and Palacios 2002), and in some studies a synthetic measure is used (Barczak 1995). Synthetic measure of new product performance combines several single measures of NPD performance in one index. This index reflects several aspects of performance which are measured by each single variable included in the index. In this way synthetic measure provides a better estimation of performance than a single measure (Hair et al. 1995, p. 9).

Fig. 1 shows the conceptual framework used for the survey and defines the scope of it.

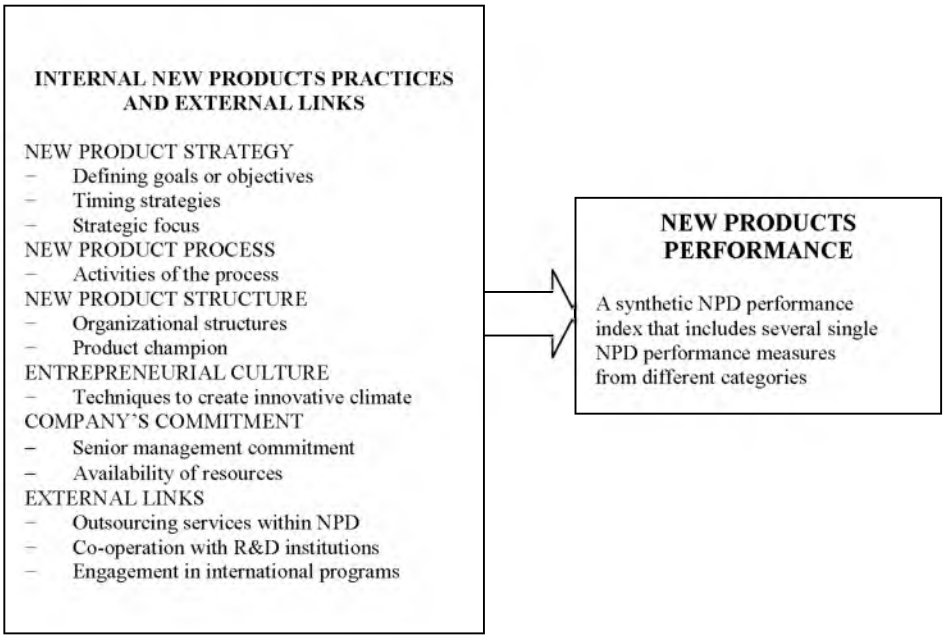

Figure 1. Survey framework

Source: author's own

2. THE STUDY METHODOLOGY

2.1. Data gathering method

A sampling frame for the survey consisted of all German producers of household appliances who were identified on the basis of two NACE codes: 29710 – manufacturers of electrical domestic appliances, 29720 – manufacturers of non-electrical domestic appliances. A list of producers was developed by using the Hoppenstedt database, where all NACE codes of a firm were taken into account. In the case of a corporation, where several business units existed, each business unit was treated as a unit of analysis (as a "firm"). The database was also used to find a person who was in charge of NPD in each firm, but in many cases there was not the name of such a person. In these cases, larger firms were contacted by sending e-mails or making telephone calls to identify new products managers, and in the case of smaller firms we identified managing directors by searching Hoppenstedt. In small and medium enterprises managing directors seem to be fully qualified to answer questions with regard to NPD, because of their relatively high involvement in NPD effort in firms of such size. Hence, we developed a mailing list of new product managers and managing directors, which was used to send an initial postcard to invite them to take part in the survey. The initial postcard was sent a week before mailing a questionnaire.

All contacts with firms from the sampling frame, which were done before mailing the questionnaire (i.e. e-mails, telephone calls, and preceding postcards) allowed us to verify the original list of producers obtained from Hoppenstedt. The original list of producers amounted to 265 units and was reduced to 250 units for several reasons. Seven initial postcards were returned because a firm did not exist or changed address, and the next eight declared that they did not develop new products or did not manufacture domestic appliances.

The questionnaire was tested before sending it to the producers. A sub-sample of seventeen respondents, which was taken from the sampling frame, received the questionnaire and the respondents were asked to comment about its comprehensiveness and clarity. For this purpose a special open-ended question was included at the end of the questionnaire. Six of these respondents returned the questionnaire and all stated that they did not have any problems with filling it.

At the beginning of May 2001 the questionnaires were mailed with a personalized cover letter and a stamped addressed envelope to all 250 firms. Two weeks later a reminder postcard was sent to each firm who did not return the questionnaire. Altogether fifty-six valuable questionnaires have been received and the response rate achieved was 22,4 percent. Table 1 shows the sample characteristics.

Table 1

Sample characteristics

Number of Employees		Sales in million Dollars		Respondents	
49 or less	25,0%	19 or less	46,4%	Technical Manager, Product Development Manager, R&D Manager	48,2%
50 - 249	35,7%	20 - 99	30,3%	Managing Director	51,8%
250 or more	39,3%	100 or more	23,3%		

Source: author's own research

We compared no responding firms with participating producers to find if any differences existed between these two groups regarding geographical location, NACE code, and number of employees (Armstrong and Overton 1977). We conducted Kolmogorov-Smirnov's test which revealed no significance differences on any of these variables between responding and no responding firms.

2.2. Measuring variables

The questionnaire was developed to measure the extent to which firms have used NPD practices and their NPD performance. For clarity a brief definition was provided for each practice considered.

To measure the extent to which a firm was applying specific NPD practices, a six-point ordinal scale was used for each practice and link. The scale had labels: 1 – "not at all" and 6 – "to a very great extent". By using such an ordinal scale we can split the sample into two following groups with regard to each practice: the first one with firms which applied a practice to a small extent (aggregation or responses 1, 2 and 3), and the second with firms which applied it to a large degree (aggregation of responses 4, 5 and 6). This kind of scale and the way of dividing a sample was already used by Barczak (1995).

With regard to new product strategy the survey concentrated on new product goals (or objectives), strategic focus and timing strategies. To measure new product objectives respondents were asked to show on the six-point scale the extent to which they defined the goals or objectives of the NPD program (Cooper and Kleinschmidt 1995). With respect to strategic focus respondents were asked to state on the six point scale: one, the degree to which they were concentrating on the market when developing new products and two, the degree to which they were concentrating on technology (Brockhoff 1988; Gerstenfeld 1976; Roper 1997). Then, in the case of timing strategies three options were used: first-to-market, fast follower and delayed entrant (Barczak 1995; Schnaars 1986). Here respondents were asked to indicate on the six-point scale the extent to which they were using each of the timing strategies.

Considering the NPD process, the following activities were distinguished by analyzing the following studies (Booz ... 1982, p. 11; Crawford and Di Benedetto. 2000, p. 25; Kotler 1991, p. 317-340): opportunity identification, concept generation and development, concept testing, concept screening, development of product prototype, customer prototype testing, marketing plan development, market testing and product introduction. To measure these activities respondents were asked to indicate on the six-point scale the degree to which their firm was engaged in each of the above activities.

To distinguish various structures a criterion *the degree of projectization* (Crawford and Di Benedetto 2000, p. 284) was used because this applies to producers of domestic appliances according to our three years of experience in this industry. Having this criterion three following structures were distinguished (Moore and Pessemier 1993, p. 111): functional organization, project matrix and venture organization. Also a new product committee and product champion were taken into account. Hence, to find the structures used for NPD, respondents were asked to show on the six-point scale the extent to which their firm was using each of the above five organizational solutions.

To characterize the entrepreneurial climate in a firm, three techniques were proposed (Cooper 1995; Crawford and Di Benedetto 2000, p. 35 and 73): *idea suggestion schemes*, *free time,* and *skunk works*. To determine a usage for each of these techniques, respondents were asked to state on the six-point scale the degree to which their company was using each of them.

With respect to a company's commitment to NPD two variables were introduced: senior management commitment (Booz... 1982, p. 17; Cooper 1995; Maidique and Zirger 1984), one variable, and availability of human, financial and technological resources (Cooper 1995), also one variable. The existence of each of these two situations in a firm was measured again on the

six-point scale, and respondents were asked to state the extent to which each of them was present in their firm.

To identify external links performed by a firm when developing new products, respondents were asked to show on the six-point scale the extent to which their firm was involved in the following linkages: outsourcing new product designs (e.g. CAD construction); outsourcing prototyping or tooling (e.g. buying rapid prototyping or rapid tooling services); outsourcing finishing, surface-technology, assembly; co-operating with scientific and R&D institutions (e.g. universities, Fraunhofer Society); engagement in international programs which promoted innovations (e.g. Eureka, framework programmes).

Finally, to measure NPD performance four variables were used which were selected from the list provided by Griffin and Page (1993). Respondents were asked to state: the number of new products introduced to the market in the last three years, the percentage of sales provided by products less than three years old (Barczak 1995; Cooper 1985; Cooper and Kleinschmidt 1986; Cooper and Kleinschmidt 1995; Gonzalez and Palacios 2002), the rate of successful new products to total number of products introduced (Gonzalez and Palacios 2002), and overall success of the NPD program (Barczak 1995; Cooper 1985). The latter variable was measured on a six-point ordinal scale with labels: 1 – "completely dissatisfied; 6 – "completely satisfied".

2.3. Data analysis

To answer the question, which of the NPD managerial practices are related to NPD performance, required several steps. Data analysis started with combining the NPD performance variables into a single synthetic NPD performance measure. This was done to have one index of performance that contained several measures coming from different categories. According to Hair et al. (1995) "multiple responses reflect the *true* response more accurately than does a single response" (p. 9). Three NPD variables were used to determine the index because one variable, the number of new products introduced to the market, appeared not to be a good measure, and this variable was not taken into account. Specifically, we found that the variable varied too much probably due to the heterogeneity of firms in our sample with regard to the complexity of products manufactured. We had in our sample producers of electrical and non-electrical domestic appliances and electrical appliances are more complex then non-electrical ones. Therefore, in terms of "numbers of new products" producers of non-

electrical appliances can report more new products than producers of electrical appliances. Hence, the variable was not showing real differences in NPD performance and could influence the synthetic measure incorrectly. Therefore the single synthetic NPD performance index was calculated with three variables by applying linear ordering methods, and we used a formula appropriate for ordinal measures (Walesiak 1996, p. 129) – see Appendix A for details – as among the three NPD performance variables we had one ordinal and two ratio measures.

On the basis of values of the single synthetic NPD performance variable the sample was divided into *higher* and *lower* new product performance producers. For this purpose a median of the synthetic performance variable was calculated, which amounted to 0.493, and the sample was split into two groups: twenty-eight firms of higher NPD performance and twenty-eight firms of lower NPD performance.

Then, following Barczak (1995), the six-point scale used to measure the extent to which each NPD practice existed, was transformed into a two-point scale. Responses 1, 2 and 3 were combined into one category called *to a small extent*, and responses 4, 5 and 6 were combined into a new category called *to a large extent*. These two categories were also used further to find out the extent to which each NPD practice was used by firms researched.

The above steps enabled the building of 2x2 tables, where one variable was the synthetic NPD performance variable, with labels *lower* and *higher* performance, and the second the extent to which each NPD practice was used, with labels *to a small extent* and *to a large extent* (see Appendix B for details). For these tables, the χ^2 test of independence was used to find a relationship between the extent to each NPD practice was applied and the synthetic NPD variable.

3. RESULTS AND DISCUSSION

3.1. New product strategy

Table 2 shows that a great majority of firms in the sample define goals or objectives of their NPD program to a large degree, hence most surveyed firms plan what they are going to achieve with respect to new products. Concerning the timing strategies, the firms are very likely to use first-to-market strategy and two other strategies are much less popular, particularly a delayed entrant strategy. The same result has been obtained in the U.S. telecommunication industry (Barczak 1995), where also first-to-market

strategy was in favour. However, Robinson et al. (1992) underline that in the case of timing strategies, later entrants tend to incorrectly report first-to-market strategy. Looking at the strategic focus, a majority of firms reported that they concentrated on the market as well as on technology to a large extent, however a market focus appeared to be preferred more than a technology one.

Table 2

Components of new product strategy used

	To a small extent	**To a large extent**
OBJECTIVES		
Defining goals or objectives of NPD program	19,6%	80,4%
TIMING STRATEGIES		
First-to-market	39,3%	60,7%
Fast follower	62,5%	37,5%
Delayed entrant	82,1%	17,9%
STRATEGIC FOCUS		
Concentrating on market	20,0%	80,0%
Concentrating on technology	42,9%	57,1%

n = 56

Source: author's own research

With respect to the relationships between components of new product strategy and performance, one explicit relationship was found, namely for the first-to-market strategy (Table 3). Hence, it can be stated that among firms which used first-to-market strategy to a large degree, more of them achieved higher performance than lower. The result is consistent with the outcomes of other studies (Robinson et al. 1985; Urban et al. 1986). The probable explanation of this fact is that in the markets, where competition is intensive and new products are improved on a continuous basis (i.e. radical new products are rare in the industry), these firms which are first in market with new products have better performance.

Table 3

Components of new product strategy and performance

		Performance		
		Lower	Higher	
First-to-market	Small extent	68,2%	31,8%	n = 56
	Large extent	38,2%	61,8%	$\chi^2 = 4,79$ p = 0,029

Note: The 2x2 table between defining goals (or objectives) of the NPD program and NPD performance was also significant (χ^2 = 5,54, p = 0,018). However, one cell had fewer than five respondents, so this relationship is not included in the discussion.

Source: author's own research

3.2. New product process

According to Table 4 six activities of the new product process were undertaken by most firms to a large degree. They were: opportunity identification, concept generation and development, concept testing, development of product prototype, customer prototype testing and market introduction. However, in the case of concept testing there was only a 1,8 percent difference between usage to a small or large degree. Two other activities, concept screening and marketing plan development, were carried out by half of the firms to a large extent, and another half to a small extent. And one activity – market testing – a majority of firms declared using to a small degree. The latter finding concurs with several other studies (Barczak 1995; Cooper and Kleinschmidt 1986; Dwyer and Mellor 1991), but it is not consistent with Page (1993). The probable explanation of omitting market testing is that this activity, apart from being costly and lengthy, can reveal a new product to rivals and this can discourage firms to take it on.

Table 4

New product process activities used

	To a small extent	To a large extent
Opportunity identification	21,4%	78,6%
Concept generation and development	23,2%	76,8%
Concept testing	48,2%	51,8%
Concept screening	50,0%	50,0%
Development of product prototype	21,4%	78,6%
Customer prototype testing	35,7%	64,3%
Marketing plan development	50,0%	50,0%
Market testing	80,4%	19,6%
Market introduction	34,7%	65,3%

n = 49 for market introduction; n = 56 for all other activities

Source: author's own research

Four new product process activities were distinctly related to new product performance (Table 5), i.e. concept testing, concept screening, marketing plan development, and market introduction. Table 5 shows that among these firms which used these four activities to a large extent, more of them obtained higher NPD performance than lower. For instance, among firms which have been engaged in concept screening to a large degree, 71,4 percent have achieved higher performance, whereas only 28,6 percent lower. Analogous conclusions can be drawn for the other three of the four new product activities. We can add that in the cases of concept testing and market

introduction our results are in agreement with the findings of Cooper et al. (2004c).

Table 5

Process activities and performance

		Performance		
		Lower	Higher	
Concept testing	Small extent	74,1%	25,9%	n = 56
	Large extent	27,6%	72,4%	χ^2 = 12,09 p = 0,0005
Concept screening	Small extent	71,4%	28,6%	n = 56
	Large extent	28,6%	71,4%	χ^2 = 10,27 p = 0,001
Marketing plan development	Small extent	67,9%	32,1%	n = 56
	Large extent	32,1%	67,9%	χ^2 = 7,14 p = 0,007
Market introduction	Small extent	64,7%	35,3%	n = 49
	Large extent	37,5%	62,5%	χ^2 = 3,29 p = 0,07

Note: The relationships were also significant between: opportunity identification and NPD performance (χ^2 = 3,82, p = 0,05), concept generation and development, and NPD performance (χ^2 = 12,1, p = 0,0005), market testing and NPD performance (χ^2 = 5,54, p = 0,02) However, in each of these cases, one cell had fewer than five respondents, so these relationships are not included in the discussion.

Source: author's own research

3.3. New product structure

According to Table 6 only a new product committee was reported to be used to a large extent by most firms in the sample. Half of the firms used the project matrix to a large degree, and other organizational solutions have been applied by a majority of firms to a small extent. According to our definition provided in the questionnaire, by new product committee – also called product approval committee (Rosenau 1996) – we meant: a committee which consists of senior (middle) management of various functions who indicate strategic guidelines for new products. Therefore this committee is usually used together with another solution (e.g. with functional structure or with project matrix) then, according to Table 6, the most probable structural

solution used by producers of domestic appliances is project matrix with a new product committee.

Table 6

New product structures used

	To a small extent	To a large extent
New product committee	37,5%	62,5%
Functional structure	66,1%	33,9%
Project matrix	50,0%	50,0%
Venture	75,0%	25,0%
Product champion	55,4%	44,6%

n = 56

Source: author's own research

Examining relationships between different new product structures and NPD performance, an explicit association was found only in the case of project matrix (Table 7). This result is consistent with the presently widely accepted belief that project teams are an outstanding means for NPD (Cooper et al. 2004a). Other studies, for example (Barczak 1995; Griffin 1997; Larson and Gobeli 1980), also confirmed the effectiveness of the project teams. Barczak (1995) explained this situation stating "as project teams exhibit allegiance to the project rather than functional area, products developed are more likely to possess features and benefits specified by customers and the industry. This, in turn, can lead to better new product performance" (p. 229).

Table 7

New product structure and performance

		Performance		
		Lower	Higher	
Project matrix	Small extent	60,7%	39,3%	n = 56
				$\chi^2 = 2,57$
	Large extent	39,3%	60,7%	p = 0,1

Source: author's own research

3.4. Entrepreneurial climate, commitment and resources

As shown in Table 8 most firms to a large extent used only an idea suggestion scheme, among techniques to create entrepreneurial climate. *Free time* and *skunk works* methods were not popular in German domestic appliances industry which is consistent with the results obtained by Cooper

et al. (2004c). A possible explanation is that these two techniques are also less known than the idea suggestion scheme. During interviews which preceded the survey, it appeared that some respondents did not know the term „skunk works". Additionally, *free time* and *skunk works* are techniques giving an organization a piece of freedom, or uncontrolled work, as it is necessary for creative work. But some top managers could be reluctant to allow employees to work without control.

Table 8

Entrepreneurial climate and company's commitment

	To a small extent	**To a large extent**
ENTREPRENEURIAL CLIMATE		
Idea suggestion scheme	46,4%	53,6%
Free time	76,8%	23,2%
Skunk works	67,9%	32,1%
COMPANY'S COMMITMENT		
Senior management commitment	8,9%	91,1%
Adequate resources	25,0%	75,0%

n = 56

Source: author's own research

A great majority of respondents in the sample declared that senior management was involved in NPD to a large degree (Table 8). In general, this is in agreement with the results of Cooper et al. (2004a) who found that top management commitment existed in 50,5% of businesses researched. In our case a very high percentage (91,1%) of firms fall within label "to a large extent". This situation is probably caused by the fact that 60,7 percent of firms in the sample were small or medium sized (Table 1). In these kinds of firms we have a close relationship between employees and senior management due to the small number of levels of management. Similarly, an availability of adequate resources for NPD was reported to be used to a large extent by most firms in the sample (Table 8).

Regarding the relationships between techniques of entrepreneurial climate, a company's commitment and new product performance, we only found a distinct relationship for adequate resources ($\chi^2 = 3,43$, $p = 0,06$). However, one cell in the 2x2 table for adequate resources and NPD performance, had fewer than five respondents, so this relationship is not treated as our finding.

3.5. External links

As shown in Table 10 each of the new product external links was used by the majority of firms to a small extent. This result means that producers of domestic appliances rely mainly on internal development in product innovation. This situation is not surprising due to several reasons. One, developing new products in-house allows a firm to control the whole process much more than relying mostly on outside partners. Two, incorporating to a large degree external partners in product innovation increases the risk of revealing information about development to competitors (e.g. about ideas, design solution or technology used). However, sometimes it is necessary for a firm to outsource some services. For example, when a firm has no proper technology, or its technology is outdated, then by outsourcing the most advanced tools a firm can achieve up-to-date standards. The results given in Table 10 confirm this fact. For instance, 41,1 percent of firms admitted to outsource prototyping or tooling (e.g. buying rapid prototyping or rapid tooling services) and 37,5 percent to co-operate with R&D institutions (e.g. universities, Fraunhofer Society) to a large extent respectively.

Table 10

New product external links used

	To a small extent	To a large extent
Outsourcing new product designs	76,8%	23,2%
Outsourcing prototyping and tooling	58,9%	41,1%
Outsourcing finishing, surface-technology, assembly	73,2%	26,8%
Co-operation with R&D institutions	62,5%	37,5%
Involvement in international programs promoting innovation	87,3%	12,7%

N = 55 for involvement in international programs; n = 56 for other activities

Source: author's own research

The involvement in international programs promoting innovation (i.e. framework programmes or Eureka) was used to the smallest extent among external links considered. This situation can be caused by several reasons, for example: too small program's resources, very high competition between applicants, or the threat of revealing ideas to competitors.

Regarding relationships between new product external links and NPD performance (Table 11), an explicit relationship was found only in the case of outsourcing prototyping or tooling. Table 11 shows that among firms which were outsourcing prototyping or tooling to a large degree, as many as 73,9 percent obtained higher new product performance, while only 26,1

percent lower. Explaining this we can say that under this link a firm incorporates in NPD the most advanced technology with its advantages, such as speed and flexibility, hence these advantages are likely to cause this positive relation with performance.

Table 11

New product external links and performance

		Performance		
		Lower	Higher	
Outsourcing prototyping or tooling	Small extent	66,7%	33,3%	n = 56
	Large extent	26,1%	73,9%	$\chi^2 = 8,93$ p = 0,003

Source: author's own research

CONCLUSION AND IMPLICATIONS

The aim of this study was to find usage of NPD practices as well as to examine their relationships to new product performance in the German domestic appliances industry. On the basis of the findings of this study, important implications and conclusions can be drawn.

The study suggests that a critical issue within new product strategy is choosing the right timing strategy in the German appliance industry. This study implies that German producers of household appliances should be first in the market with their new products. However, this strategy has the highest risk among all timing strategies, so this could be the reason why some firms using this strategy obtain low new product performance. But, on the other hand, if a firm's new products are modernized and are not "new to the world" – as is common in the household appliances industry – then the risk of first-to-market strategy is lower, and a firm can explore the opportunity of being the first (for example in terms of market share or brand image).

The study clearly underlines the crucial role of several activities of new product process in German appliance industry. They are as follows: concept testing, concept screening, marketing plan development, and market introduction. The first two of the mentioned activities, i.e. concept testing and concept screening, are in the "fuzzy front end" of the process. At this stage of the process, we usually still do not have high costs of product development. Therefore firms with low usage of these activities should employ them to a higher extent as they are used at an intermediate level.

Also another activity, critical for high NPD performance, is not used at a high level – namely marketing plan development – hence new product managers should make more use of this activity.

This study – similar to other works dedicated to find efficient new product structures – underlines the importance of project matrix. In the German appliances branch, as in other industries (Barczak 1995; Cooper and Kleinschmidt 1995), project teams seem to be also an effective structure of organizing NPD. However, the usage rate of project matrix in this industry is at an intermediate level, thus firms are encouraged to apply this structure to a higher degree.

Outsourcing rapid prototyping or tooling is related to better new product performance in the German appliance industry, and, on this basis, we can recommend this practice to producers. But it is thought that this positive effect is caused by incorporating the most advanced technology (with its advantages) into the new product process. Furthermore, we can expect that using in-house rapid technology would have a more positive effect on new product performance than outsourcing it, due to extra advantages (e.g. lower risk of revealing our development to competitors, higher control).

This study is limited by several factors that should be addressed in future research. First, it is a single industry and a one country study. In this way we received quite homogeneous population with regard to the type of activity, but relatively small. It amounted to about 250 German producers of domestic appliances who still differed in types of products, i.e. electrical and non-electrical appliances, and in company size. Consequently, our sample with regard to the type of activity was homogenous, but with respect to the type of product or company size it was heterogeneous. Hence, in the case of a single industry study we recommend to conduct a cross-country study. This will allow to control not only the type of activity, but also other variables such as company size or type of product, and if we, for example, consider the whole of Europe, then the population will be much bigger than in this research.

Second, our study rather focused on "what should be done" than "how it should be done" in the German appliance industry. We tried to find out new product practices which had a positive impact on new product success, but we did not consider ways in which these practices should be performed. Future research could address these issues. For instance, further studies could examine the following issues: in which way a company should set up new product goals and objectives on a firm level? What would be the best way to conduct each activity of new product development process?

Third, one consideration not taken into account in this study is the impact of using in-house rapid prototyping (or tooling) on new product performance in the German appliance industry. We would expect to observe a positive influence of this factor on new product success, but this influence should be compared with an alternative solution, that is outsourcing this technology within a firm. Company size could play a crucial role in this issue. Probably for a small firm it would be better to outsource, but in the case of large companies it would be better to have it in-house.

APPENDIX A

The formula – assuming that we have a set of objects A described by m ordinal variables – enables the finding of a distance of an object i to an object w (called a "pattern object") in the following way (Walesiak 1996, p. 129):

$$d_{iw} = \frac{1}{2} - \frac{\sum_{j=1}^{m} a_{iwj} b_{wij} + \sum_{j=1}^{m} \sum_{\substack{l=1 \\ l \neq i,w}}^{n} a_{ilj} b_{wlj}}{2\left[\left(\sum_{j=1}^{m} a_{iwj}^2 + \sum_{j=1}^{m} \sum_{\substack{l=1 \\ l \neq i,w}}^{n} a_{ilj}^2\right)\left(\sum_{j=1}^{m} b_{wij}^2 + \sum_{j=1}^{m} \sum_{\substack{l=1 \\ l \neq i,w}}^{n} b_{wlj}^2\right)\right]^{\frac{1}{2}}},$$

where

$$a_{ipj}\left(b_{wrj}\right) = \begin{cases} 1, & for \quad x_{ij} > x_{pj} \ \left(x_{wj} > x_{rj}\right), \\ 0, & for \quad x_{ij} = x_{pj} \ \left(x_{wj} = x_{rj}\right), \\ -1, & for \quad x_{ij} < x_{pj} \ \left(x_{wj} < x_{rj}\right), \end{cases}$$

$p = w,l; \quad r = i,l; \quad i,w,l = 1,...,n$ - number of object,

$j = 1,...,m$ - number of ordinal variable,

$x_{ij}\left(x_{wj}, x_{lj}\right)$ - i (w, l) observation of j ordinal variable.

The pattern object is an object created in this way that for each of m variables it has the highest (or lowest) variable value. Hence being a "pattern object" to which each of the other objects is compared.

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APPENDIX B

2x2 table

Specification		Y		
		y_1	y_2	$n_{i.}$
X	x_1	a	b	$a + b$
	x_2	c	d	$c + d$
$n_{.j}$		$a + c$	$b + d$	n

Source: author's own on a base of Barczak (1995)

Y – a synthetic performance variable with two following labels: *lower* performance (y_1) and *higher* performance (y_2). X – a variable representing the extent to which a certain practice of NPD was used with two labels: *to a small extent* (x_1) and *to a large extent* (x_2).

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