Are Methods the Key to Product Development Success? An Empirical Analysis of Method Application in New Product Development

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Abstract This article analyzes method application in the context of new product development. Based on a study of 410 new product development projects, it is shown that applying methods in new product development leads directly to superior financial performance of the developed product (by reducing product costs, for example) and also leads indirectly to a greater degree of innovativeness, better cross-functional collaboration, and shorter time to market. The optimal combination of different method categories is examined and two key determinants of the successful adoption of new product development methods are analyzed, showing how firms can actively improve on what in some cases are very high failure rates of new products.

1 Introduction: Method Application in New Product Development

New product development (NPD) is one of the most important determinants of sustained company performance and therefore represents a key challenge for many firms. Accordingly, numerous authors have focused their research on improving new product development and identified several success factors, including cross-functional collaboration during product development, fast times to market, and product innovativeness. Ernst (2002) and Poolton and Barclay (1998), for example, provide sound overviews of success factors for new product development. Compared to these factors, all of which have already been studied very intensively, relatively little research has so far been conducted into the use of methods in new product development (Nijssen and Frambach 2000). Notwithstanding, studies in this field clearly show that precisely the adoption of product development methods is crucial to the performance of development projects (see Graner and Mißler-Behr 2012).

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In summing up the findings of the extensive innovation study conducted by the Product Development & Management Association in the USA, Barczak et al. (2009), for example, note that: “In terms of aspects of NPD management that differentiate the ‘best from the rest,’ the findings indicate that the best firms […] use numerous kinds of new methods and techniques to support NPD.” The structured use of methods can indeed be a very effective way to help generate new ideas and improve companies’ ability to innovate (Fernandes et al. 2009).

This article aims at analyzing method application in the context of new product development projects. To consider both key determinants and direct and indirect effects of method application, a comprehensive research model is required. Based on a structural equation modeling (SEM) approach and on a large empirical sample of 410 product development projects the individual effects of those factors are analyzed in detail. Methods used by several corporate functions involved in new product development such as Engineering/R&D, Market Research, Purchasing, Quality Management or Logistics are considered. The methods investigated are selected using a systematic process based on defined selection criteria. By doing so, this article seeks to answer the following questions:

- What are key determinants of successful method application?
- What are the direct effects of method application in new product development on the success of the product?
- How does method application affect cross-functional collaboration, time to market and product innovativeness, and thereby influence product success?
- Which combination of methods from different categories can help to develop particularly successful products?

2 Research Framework and Key Hypothesis

Based on existing research, a comprehensive research model was developed which is displayed in Fig. 1. It contains key frame conditions for the adoption of methods in the context of new product development (left side of the model) and both the direct impact of method application on NPD success and the indirect impact of method application via time to market, cross-functional collaboration and product innovativeness (right side of model).[1]

[1]A detailed description of the research model, the statistical analysis and the results can be found in Graner and Mißler-Behr 2013 (isolated analysis of key determinants of method application); Graner and Mißler-Behr 2014 (impact of method application specifically on cross-functional collaboration on product success) and Graner 2013 (comprehensive model, in German language).

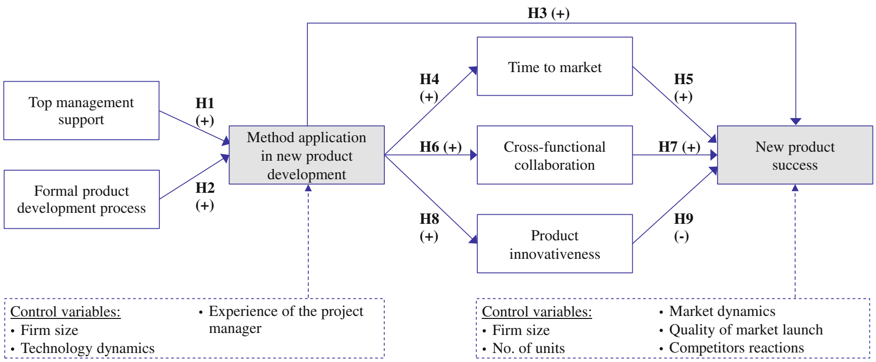

Fig. 1 Conceptual model (see Graner 2013). The hypnosis's are explained in the following paragraph. (+/-: A positive/negative influence is postulated)

2.1 Frame Conditions of the Successful Adoption of New Product Development Methods

Little research has so far been conducted into frame conditions of successful method application in the context of new product development and especially analyzing frame conditions together with the effects of method application in a comprehensive research model (see Graner and Mißler-Behr 2013). Nijssen and Frambach (2000), for example, focus mainly on requirements for the successful adoption of methods in new product development. They point out that the degree to which a company formalizes the new product development process and the support given by top management to NPD projects have a material influence on the use of methods in new product development. Based on this study and supplemented by the results of Ettlie and Elsenbach (2007), Thieme et al. (2003), and Geschka and Dahlem (1996) two key determinants for successful method application were analyzed: *Top management support* and the *formalization of the product development process.*

2.1.1 Top Management Support

Several studies (see Ernst 2002; Henard and Szymanski 2001) confirm the role of top management support as an important success factor in new product development. Top management has a crucial influence on both the wider culture of innovation in firms (Poolton and Barclay 1998) as on individual development projects. For example, the use of methods in new product development often requires financial and human resources that must first be made available by the appropriate management level (Ernst 2002). Nijssen and Frambach (2000) show that the degree of top management support has a significant influence on the application of methods in new development projects. The results of Thia et al. (2005) support this conclusion. Geschka and Dahlem (1996) too point out that a supportive attitude on the part of management is a precondition, in particular if methods are to be applied successfully. Thieme et al. (2003) demonstrate that top management support for new product development projects is key to the quality of project planning and the use of certain methods, such as quality function deployment (QFD). In light of these research findings, the following link is postulated: Top management support has a positive impact on the application of methods in new product development projects (hypothesis 1).

2.1.2 Formal Product Development Process

The impact of a formal product development process on new product success has also been confirmed by previous research (Ernst 2002; Henard and Szymanski 2001). Where a company's new product development process is split into several phases with defined decision gates, it is also to be expected that financial or technical evaluation methods, for example, will be used as the basis for decision-making. Nijssen and Frambach (2000) show that the more heavily the development process is formalized, the more methods are used in new product development. Ettlie and Elsenbach (2007) likewise prove that firms that operate a structured development process deploy more new product development methods. Indeed, at some firms, the new product development process is formalized to such an extent that the application of certain methods (such as specific quality or market research methods) is actually prescribed. In such cases, the decision whether to use a method is no longer made solely by the individuals involved in the project. This explains why the degree to which the process is formalized might influence whether methods are applied in new product development projects. The second hypothesis is therefore: The existence of a formal, structured new product development process has a positive impact on the application of methods in new product development (H2).

2.2 Direct Impact of Method Application on NPD Success

The correlation between the *use of methods in new product development* and the *success of the developed product* has been substantiated in a number of studies (see Graner and Mißler-Behr 2012). Market research methods (such as conjoint analysis) can be used to gain a better understanding of specific customer needs (and their willingness to pay) and, based on these insights, to develop the product or individual product components in a way that improves the benefit to the customer and maximizes the financial success of the product. The adoption of purchasing methods at an early stage can help to reduce the cost of materials for the product. Design methods and approaches such as concurrent engineering and design for manufacturing can help to find better technological solutions and to cut the cost of product development, thereby also reducing the subsequent cost of production.

A whole series of methods can therefore be applied in new product development in a way that increases the financial performance of the product. The following central hypothesis is thus proposed: The use of methods in new product development has a positive impact on the financial performance of the product (H3).

2.3 Indirect Impact of Method Application via Time to Market, Cross-Functional Collaboration, and Product Innovativeness

The duration of the development project too is an important success factor in new product development (see Henard and Szymanski 2001). Development projects that are completed quickly tie up fewer resources and enable a faster *time to market*. In many cases, fast new product development also gives firms a head start relative to the market launch of competitor products. This can favor deeper market penetration and a longer product life cycle overall, both of which lead to higher revenues. At the same time, the cost of development can be spread across a larger number of products. For these reasons, a raft of studies and meta-analysis confirm the positive impact of a short development process on the success of innovation (see Graner 2013). Evans (1990) and Dumaine (1989) investigate the cost of slow times to market and determine that delaying market launch by 6 months can cost a firm up to a third of profits in the first 5 years.

Research findings vary regarding the impact of the use of methods on the *time to market*. Some authors argue that applying certain methods costs extra time and thus slows development projects down (Thia et al. 2005; Eisenhardt and Tabrizi 1995). Contrary to this view, however, project staff often saves time if methods are adopted. Cordero (1991) demonstrates this with regard to the use of computer-aided design/manufacturing/engineering. Sun and Zhao (2010) identify a positive correlation between the use of multiple methods (including TQM, QFD, and value analysis) and the speed of new product development. Griffin (1993) and Barczak et al. (2009) likewise confirm that certain methods can help to reduce product development cycle time. Thus the following hypotheses are proposed: The use of methods shortens the development runtime and improves time to market (H4). Projects with faster time to market meet with greater financial success (H5).

Cross-functional collaboration of new product development teams is another key success factor for NPD, substantiated by several studies (e.g., Slotegraaf and Atuahene-Gima 2011). The more closely the people from different functions (such as R&D, production, marketing, purchasing, and logistics) coordinate their activities and the more they share relevant information, the more successful the development project will be.

Precisely, the application of methods often requires all kinds of information from a variety of functions (Nijssen and Frambach 2000). For example, technical specifications and/or product samples are sometimes needed before market research methods can be applied. On top, most methods are often used in combination and require or provide input from or for other methods that are applied from other corporate functions (Lindemann 2003). Therefore, the use of more methods often leads to closer collaboration between the people and functions involved in the project. Thus the following hypotheses were developed: The use of methods has a positive impact on cross-functional collaboration (H6). Cross-functional collaboration during product development has a positive impact on product success (H7).

A third key factor influencing the success of the newly developed product is its *degree of innovativeness*. A wide range of studies confirm this assertion (Danneels and Kleinschmidt 2001; Henard and Szymanski 2001; Song and Montoya-Weiss 1998). Heated debate nevertheless rages regarding the specific impact of innovativeness. To date, different studies have thus identified both positive correlations between innovativeness and NPD (e.g., Gatignon et al. 2002; Song and Montoya-Weiss 1998) and negative ones (e.g., Horsch 2003). On the one hand, more innovative products that satisfy customers' needs better than existing products are attractive to customers and therefore often enjoy substantial market potential. In addition, firms that pioneer innovation often attract considerable attention. On the other hand, however, products that are *too* innovative are sometimes ahead of their time. Moreover, pioneers often struggle with the product's "teething troubles" and shoulder most of the burden of development. Followers can learn from mistakes made by the pioneers and develop mature products at better prices (or at better cost). A majority of research work thus concludes that innovativeness tends rather to have a negative impact on the financial performance of a product (see the overview provided by Schlaak 1999).

The use of methods can materially influence the innovativeness of the product. Market research methods, for instance, can help a firm to better understand the needs and areas of application that are of interest to the end customer. This knowledge allows them to develop more innovative products with new and better features (Song and Xie 2000). At the same time, the adoption of research and development methods can help the new product development team to develop alternative technological solutions. Thus the following hypotheses are proposed: The use of methods leads to more innovative products (H8). Overall, a high degree of innovativeness has a negative impact on the success of the newly developed product (H9).

2.4 Control Variables

Variations in the factors "technology dynamics," "market dynamics," "quality of market launch," "reaction of competitors," "number of units produced," "firm size," and "experience of the project manager" were controlled in order to be able to quantify the influence of the described determinants and effect of method application in isolation. A detailed argumentation including a description of all items can be found in Graner (2013).

3 Method Selection and Measure Development

The analyzed methods were selected in a systematic process. First, an exhaustive literature review evaluated existing studies of the use of methods in new product development, focusing on the methods examined by these studies. A survey of 50 product developers and experts was then used to select the most relevant methods (see Graner 2013). The survey covered individuals from 17 companies (including mechanical, automotive, process and medical engineering firms), each of whom had several years' experience of new product development, and scientists representing various engineering disciplines, quality management, and economics. These experts were asked to select those methods that are adopted especially frequently in the context of new product development or that are especially important to new product development and that, for this reason, should be included in the main investigation. The methods regarded as important by at least 50 % of the respondent experts were selected. In this way, 29 methods of particular relevance were identified. During a questionnaire pretest, very similar methods were then combined. As a result, a total of 26 methods were selected. The full list of methods can be found in the appendix. In the main investigation, the same questions were asked for each method: 1. Was the method used in the development project? (Yes/No). 2. How intensively or thoroughly was it used? (Five-point scale with anchor points: 1 = very low intensity and 5 = very high intensity/method applied very thoroughly). Additionally, the participants were asked whether other methods were also used in the project. Where this was the case, these extra methods too were evaluated. The measurement scale for method application was than calculated as the product of the frequency and intensity of application (see Graner 2013).

New product success (Cronbachs's $\alpha = 0.94$) was measured with six items, such as "market share relative to the firm's stated objectives," "product revenues relative to stated objectives," and "return on investment relative to stated objectives."

Cross-functional collaboration ($\alpha = 0.88$) was measured with four items, such as "in the product development project, different departments fully cooperated in generating and screening new ideas," "… fully cooperated in establishing goals and priorities," and "…were adequately represented and involved in the project teams."

Product innovativeness (Cronbachs's $\alpha = 0.74$) was measured with three items, such as "the technology of the product was new to the firm" and "the product reflects radical differences from industry norms."

Time to market (Cronbachs's $\alpha = 0.82$) was measured with four items, such as "speed of the development project compared to the project time goals and plans," "…compared to industry norms," "…compared to initial expectations" and "…compared to a typical product development project in your firm."

Top management support (Cronbachs's $\alpha = 0.83$) was measured with four items, such as "top management authorized all required resources for the development project," "top management supported the development project throughout the entire development process" and "top management was very actively involved in the project throughout the entire development process."

The degree to which a company formalizes the new product development process (α = 0.83) was measured with five items, such as "our firm uses a formal NPD process with a standardized set of stages and defined decision gates," "our NPD process has clearly defined go/no-go decision gates for each stage in the process" and "our NPD process lists and defines which methods (e.g., FMEA, QFD) must be applied at each stage of the process."

See Graner (2013) for a full list and exhaustive wording of all items.

4 Survey of 410 Product Development Projects

The data for the investigation of method application in new product development was collected between April and August 2011 via computer-assisted telephone interviews. A team of specially trained interviewers was assembled to conduct the interviews in order to guarantee a constant, high data quality and to do justice to both the target group and the complexity of the subject matter. The telephone interviews were conducted with manufacturing companies that operate their own new product development from bases in Germany, Austria, and Switzerland. The methods described by Frohlich (2002) were used to increase the response rate, including advance telephone contact with respondents (to arouse their interest in the survey and arrange an appointment for the interview), focused approaches to R&D managers, preliminary questionnaire testing during several conversations, and the use of existing, proven scales. Respondents had to be able to make informed statements about two completed new product development projects. Accordingly, the target group for the survey (as in the case of Chai and Yan 2006 and Langerak and Hultink 2006) included experienced product development managers and project managers who had been involved in the relevant new product development projects. In total, the data from 201 companies could be used without restriction and the data from 8 companies could be used for one project each. This is equivalent to a response rate of 17 %. A total of 410 new product development projects were assessed in this way.

The companies surveyed represent a broad spectrum of manufacturing firms. The majority come from the mechanical engineering and metalworking industries (35 % of the respondents), automotive and vehicle engineering (26 %), electrical/measurement/control system engineering and optics (14 %), and plant engineering (13 %). The interviews also covered a balanced mix of large, medium-sized, and smaller firms in revenue terms. The sample thus comprises companies with annual revenues of between EUR 6 million and more than EUR 1 billion. In terms of the number of employees too, the respondent companies reflected a balanced spread. Smaller enterprises with up to 500 employees accounted for 37 % of the sample, while medium-sized to large companies with up

Table 1 Core data for the respondent companies

Industry sector	%	Company size in terms of revenue (EUR m)		Company size in terms of full-time employees	
Mechanical engineering and metalworking	35	<50	18 %	<250	15 %
Automotive and vehicle engineering	26	50 to <100	16 %	250 to <500	22 %
Electrical/measurement/control systems engineering, optics	14	100 to <250	24 %	500 to <1000	17 %
Plant engineering	13	250 to <1000	28 %	1000 to <5000	26 %
Other (building materials, aviation, plastics,…)	12	>1000	14 %	>5000	20 %
Year of market launch	%	Project duration		Annual production volume (units)	
2011	15	1 year	29 %	<10	19 %
2010	27	2 years	33 %	10 to <100	15 %
2009	16	3 years	22 %	100 to <1000	12 %
2008	12	4 years	8 %	1000 to <10,000	15 %
2007	11	> 4 years	8 %	10,000 to <100,000	12 %
Before 2007	19			>100,000	27 %

to 5,000 employees accounted for 43 % and very large companies with more than 5,000 employees for 20 % of the sample. The detailed breakdown is shown in Table 1:

The analyzed projects were very recent. More than 80 % of the newly developed products had been launched on the market no more than 4 years before the data was collected (2007–2011). In terms of project duration, around one-third of the projects surveyed had runtimes of less than 1 year. Another third ran for between 1 and 2 years, while longer running projects that lasted three or more years accounted (approximately) for the final third. This breakdown is peculiar to manufacturing industries, which tend to have relatively long average development runtimes. The average duration of new product development was just over 2 years. The volume of units produced again reflects a balanced distribution. The sample thus contains single and very small batches (with less than 10 units per year), small batch series (with less than 100 units per year), and large batch series (with more than 100,000 units per year).

5 Analysis and Statistical Results

To test the hypothesis, a structural equation modeling (SEM) approach was employed. The analysis was conducted using the partial least square (PLS)-based SmartPLS software (Version 2.0.M3, Ringle et al. 2011). The validity and reliability of the variables and the constructs were assessed according to the criteria proposed by Hair et al. (2012) and Chin (1998) including indicator reliability (indicator loadings ≥0.7), internal consistency reliability (composite reliability ≥0.7), convergent validity (average variance extracted, AVE ≥ 0.7) and discriminant validity (Fornell–Larcker criterion).

According to Hair et al. (2012), the primary criterion for inner model assessment is the coefficient of determination (R^2), which represents the amount of explained variance. Our total R^2 for product success is 0.45, which is fairly good considering the broad range of influencing factors on new product performance. In addition, the substantial explanatory contribution made by the factors and the forecasting relevance of the model were tested and confirmed based on the strength of the f^2 effect and based on Stone-Geisser's Q^2 (Chin 1998). The stability of constructs was assessed through bootstrapping (n = 410), which estimates the t-values of the path coefficients. All constructs passed these tests. A detailed description of all construct-specific criteria can be found in Graner (2013). The results of the tests performed on the hypothesis are displayed in Fig. 2 and will be explained below.

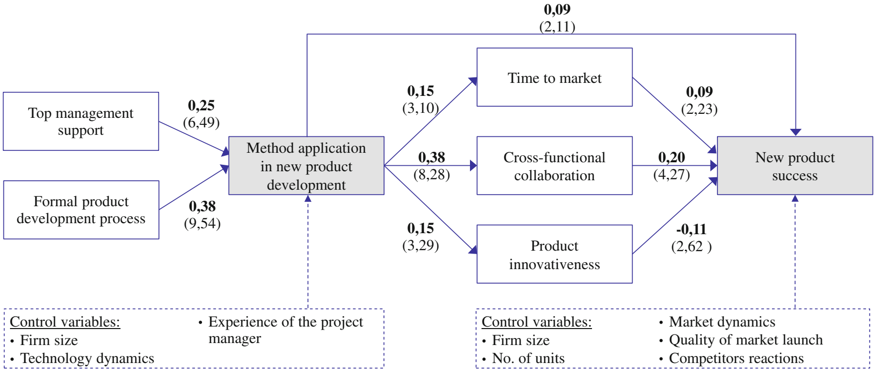

Fig. 2 Key determinants and impact of method application in new product development (path coefficients and t-values)

5.1 Frame Conditions of the Successful Adoption of New Product Development Methods

In accordance with prior research into method application in NPD, Hypothesis 1 regarding the positive impact of *top management support* was fully corroborated. A coefficient of 0.25 and a *t*-value of 6.49 (see Fig. 2) indicate that top management support does indeed have a positive impact on the use of methods in new product development.

The existence of a *formal, structured new product development process* likewise positively affects the adoption of methods in new product development, with a coefficient of 0.38. A *t*-value of 9.54 makes this correlation too significant. Hypothesis 2 is therefore also clearly confirmed.

Comparison of both factors shows that the development process has a greater influence on the application of methods than does the support of top management. The path coefficient for the factor "formal product development process" is approximately 50 % higher.

5.2 Direct Impact of Method Application on NPD Success

Hypothesis 3 regarding the correlation between the *use of methods in new product development* and the *success of the developed product* could also be also confirmed (path coefficient = 0.09, $p < 0.05$, see Fig. 2). Product development projects, that adopt more methods and use them particularly thoroughly meet with an overall higher product success.

5.3 Indirect Impact of Method Application on NPD Success via Time to Market, Cross-Functional Collaboration, and Product Innovativeness

In terms of *time to market*, it was first postulated that the use of methods has a positive influence on the speed of product development and thereby shortens time to market (Hypothesis 4). In line with this reasoning, the results display a positive correlation ($b = 0.15$, $p < 0.01$). Second, a positive influence of short time to market on NPD success could be identified ($b = 0.09$, $p < 0.05$), thereby also confirming Hypothesis 5.

In terms of *cross-functional collaboration*, it was postulated that the use of methods has a positive influence (Hypothesis 6). In line with the above explained reasoning, the results display a strong and positive correlation ($b = 0.38$, $p < 0.01$). Second, a significant positive influence of cross-functional collaboration on NPD success was identified ($b = 0.20$, $p < 0.01$), thereby also confirming Hypothesis 7.

Regarding Hypothesis 8, the results reveal a positive effect of method application on *product innovativeness* (b = 0.15, p < 0.01) but a significant negative influence of product innovativeness on NPD success (b = −0.11, p < 0.01), thereby also confirming Hypothesis 9 (see Fig. 2).

5.4 Influence of Control Variables

All the control variables that were taken into account were likewise significant. *Technology dynamics* and firm size both had a positive impact on method application, although the influence of technology dynamics was stronger. Markets characterized by fast technology dynamics experience frequent shifts in technology and are open to a wide variety of possible technologies. Firms that operate in such a context use more methods and apply them more intensively.

As expected, large companies (control variable *firm size*) that have both commensurate financial and human resources also adopt more methods. By contrast, the *experience of the project manager* had a slight negative influence on the use of methods. Very experienced project managers use less methodological support in order to make decisions and achieve outcomes, while in experienced project managers apply more methods in their new product development projects.

Out of the control variables for product success investigated, the *quality of market launch* and the reaction of competitors to the new product have the most powerful effect. While the firm is in a position to directly influence the quality of market launch as an important success factor, the *reaction of competitors* can at best be influenced indirectly (for example, due to the timing of market launch). Interestingly, however, a positive correlation between competitor reaction and the success of the product was identified. Competitors react especially vigorously to successful new products in particular. Seen from this angle, a forceful reaction on the part of competitors (such as price cuts) should not be regarded solely as disadvantageous, but rather as a sign that the developed product is particularly promising.

The *number of product units made* likewise correlates positively to the success of the product. On average, mass-produced products generate greater financial success than single batch series or very small batch series. Similarly, *market dynamics* also has a slightly positive effect on product success, and hence a mild stimulant effect in the sense that this factor forces companies to develop “better” products. By contrast, *firm size* exhibits a slightly negative correlation to financial performance. While larger companies tend to use more methods, they are still less successful than smaller firms.

5.5 *The Optimal Combination of New Product Development Methods*

Besides investigating method application in the above-described SEM model, the study also assessed the impact of combining methods from different categories (such as market research and purchasing methods). Based on a t-test for two independent samples, it was examined whether statistically significant differences occur between the success of those projects that use methods from several categories (such as market research and purchasing methods) and those that do not.

To do so, the combination of marketing research methods (which provide information about what customers want and thus primarily influence revenue) and purchasing methods (which affect product costs) were investigated (A). The underlying hypothesis is: If methods are used that take account of both the *customer demand* (and willingness to pay) dimension and the p*roduct cost* dimension during new product development, this should, on balance, lead to higher product margins.

In addition (B), a combination of methods that focused, respectively, on *customer demand* (such as marketing research methods), *technological feasibility* (research and development methods and quality and logistics methods), *product cost* (purchasing methods), and *project management* were investigated.

Several groups of projects were compared. The first comparison concerned those projects in which *at least one method* was used from each of the two categories A/B (1). In light of the generally considerable use made of methods in the overall sample, few firms did not satisfy this criterion. For this reason, a comparison of those groups that used *at least two of the methods* (2) and those that used an *above-average number of methods in each category* (3) was also made.

All in all, differences in financial success were examined for six different combinations:

- A.1: At least one method in the marketing research category and at least one purchasing method
- A.2: At least two methods in the marketing research category and at least two purchasing methods
- A.3: An above-average number of methods in the marketing research category and in the purchasing category
- B.1: At least one method each in the categories marketing research, research and development, quality and logistics, purchasing and project management
- B.2: At least two methods each in the categories marketing research, research and development, quality and logistics, purchasing and project management
- B.3: An above-average number of methods in the categories marketing research, research and development, quality and logistics, purchasing and project management

Table 2 Additional product success when multiple methods are combined

Criteria	No. of projects		Mean success		Delta[a]	Std. dev.	T	Df	Sig. (2-sided)
Criteria met?	No	Yes	No	Yes					
A.1: At least one method each from purchasing and marketing research applied	54	352	**–0.34**	**0.05**	0.40	0.14	2.74	404	**0.006****
A.2: At least two methods each from purchasing and marketing research applied	140	266	**–0.15**	**0.08**	0.23	0.10	2.20	404	**0.028***
A.3: Above-average number of methods from purchasing and marketing research applied	238	168	**–0.12**	**0.18**	0.30	0.10	3.01	404	**0.003****
B.1: At least one method each from all categories applied	88	318	**–0.28**	**0.08**	0.36	0.12	3.08	404	**0.003****
B.2: At least two methods each from all categories applied	208	198	**–0.10**	**0.11**	0.21	0.10	2.14	404	**0.033***
B.3: Above-average number of methods from all categories applied	302	104	**–0.09**	**0.26**	0.35	0.11	3.13	404	**0.002****

[a]The average difference in the mean financial success between projects that satisfy the criteria (e.g. that used at least one purchasing method and market research method) and projects that does not
$^{*}p \leq 0.05$; $^{**}p \leq 0.01$

Table 2 shows that those projects that satisfied the relevant criteria in each case (e.g., at least one method from all categories in the case of B.1) experienced substantially higher financial success than those projects that did not satisfy these criteria.

For all combinations, the difference in the mean success displays a high level of statistical significance. It can therefore be stated that projects that use a combination of multiple methods covering customer demand (and willingness to pay), product cost, technological solutions, and efficient project management are significantly more successful than projects that take account only of isolated dimensions.

Accordingly, a balanced combination of different methods appears to be of particular importance to the success of a development project. This assertion is reflected in the notable success of those development projects that use a lot of methods from all categories (Table 2).

6 Discussion of Results and Implications for Practice

The outcomes of this study of 410 new product development projects yield to a series of interesting insights both for scholars as well as for product development managers. It became evident that companies that make greater *use of methods* in new product development achieve significantly greater success in innovation.

Besides the direct effect on product success (e.g., better price levels or reduce material cost) also indirect effects on product success via time to market, cross-functional collaboration, and product innovativeness were revealed in this study.

The statistical results clearly depict that development projects that adopt more methods and use them particularly thoroughly and intensively are executed faster. The resultant products can thus be launched on the market more quickly. Moreover, a faster *time to market* also often gives the firm a head start relative to the market launch of competitor products. This can favor deeper market penetration and a longer product life cycle overall. The analysis of the 410 product development projects clearly showed that products with a shorter development cycle generally meet with greater financial success.

The factor *cross-functional collaboration* in product development projects provides a particular strong link between method application and product success. In projects in which more methods are adopted, staff involved in the project engage in more dialog across functions and generally work better together. Further, the more closely employees from the various functions (such as R&D, production, marketing, purchasing, and logistics) collaborate and the more they share relevant information, the more successful the development project will be.

The analysis also shows that companies that use more methods in new product development ultimately develop more innovative products. Market research methods, for instance, can help a firm to better understand the needs of the end customer and develop more innovative products to satisfy these needs. In light of these findings, the project owners must reconsider the targeted degree of innovativeness in the developed product. The findings show that excessive innovativeness has a negative impact on the success of the product. However, since a high degree of innovativeness is not an inevitable consequence of using methods, it is up to the project owners to actively choose a degree of innovativeness that is not excessive and consciously to avoid launching radically new products on the market. At this point, it must be pointed out that this suppressor effect exerted by the mediator innovativeness is by no means inevitable. Using methods in new product development will not necessarily lead to more innovative products. The degree of innovativeness can be consciously controlled in the course of new product development. Furthermore, the statistical method adopted delivered the mean of 410 projects. In isolated cases, highly innovative products can indeed be very successful.

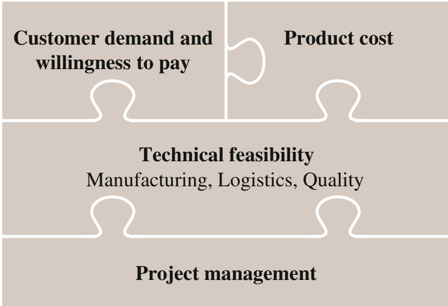

Fig. 3 Recommendations matrix for the use of methods

All in all, the empirical findings clearly confirm the overall positive *impact of method application on the success of new product development*. The managerial implication is therefore that product development teams should foster the adoption of existing methods. Especially the revenue components, cost considerations, and technical feasibility should all be carefully considered and weighed against each other in the context of any given project. Rigorous project management is also needed if new products are to be developed quickly and with the efficient use of resources. Companies that use methods to consider all those aspects, that are displayed in Fig. 3, will meet with an overall higher product success.

To foster method application companies should set the right *frame conditions* for their development projects. Especially, the *design of the development process* has a powerful influence. Companies that have formally defined the new product development process, which split this process into individual process steps, that evaluate the status of development at the end of each step and that decide whether to continue the development project at defined gates in the process tend to use more methods in new product development. The existence of decision gates with clearly defined deliverables thus demands concrete outcomes even while new products are still being developed (such as a technical concept or an economic feasibility assessment, for example). Supported by the individual methods, better outcomes can be achieved with a clearer focus.

Top management support is a second determinant for successful method application in development projects. Product development teams that receive greater support from the management (by having adequate human and financial resources approved, for example) adopt substantially more methods. By conducting more systematic market research, for example, they are able to develop products that fit customer needs more closely and are therefore more successful. Firms that are seeking a more methodical approach to new product development can choose the right combination of methods to increase the success rate of their new product development activities.

Consequently, the same attention must be given to the speed of the development project, a profound cross-functional collaboration in the development project and the degree of innovativeness of the developed product.

Notwithstanding, the results of this study also show that, even when taken together, the use of methods, time to market, cross-functional collaboration, and product innovativeness are unable to fully explain the success of a new product, which depends on a large number of factors of influence (such as the quality of market launch and the reaction of competitors). Despite this constraint, however, they remain important aspects of new product development success—aspects that firms can influence directly, thereby consciously increasing the success rate for the development of new products.

7 Three Most Important Messages for the Transfer of Research into Practice

- The use of methods in new product development has a positive impact on the financial performance of the developed product. Companies should therefor set the right frame conditions and foster method application in product development projects.
- Product development projects that use a combination of multiple methods covering customer demand, product cost, technological solutions, and efficient project management are significantly more successful than projects that take account only of isolated dimensions. Accordingly, a balanced combination of different methods appears to be of particular importance to the success of the developed product.
- Besides the direct effects on product success (e.g., better price levels or reduce material cost), also indirect effects on product success via time to market, cross-functional collaboration and product innovativeness were revealed.

Appendix: Investigated Methods

Method/approach	Description
Research and development	
Simultaneous/concurrent engineering	Simultaneous, distributed development, e.g., involving different development teams and/or locations
Design for manufacturing/assembly (DFM/DFA)	Attention to or improvements in the "manufacturability" of the product (or of product costs) during the development phase
Computer-aided engineering/design (CAE/CAD)	Use of computers as new product development tools, e.g., for design and technical drawing activities

(continued)

(continued)

Method/approach	Description
Quality function deployment (QFD)/house of quality	Method of identifying and evaluating product components that affects customer benefits (what does the customer want and how can it be realized on a technological level?). To this end, the benefit that a product component yields for customers (e.g., long standby times for mobile phones) is translated into technological and quality requirements (e.g., requirements placed on the battery and the display)
Standardization/modular design	Standardization of product components and, where appropriate, use of modular building blocks to increase the number of identical parts (with the aim of reducing complexity and cutting costs)
Collaborative supplier integration in product development	Active involvement of suppliers in product development, e.g., by running ideas competitions
(Rapid) prototyping	Various manufacturing methods for the rapid production of prototype parts (e.g., 3D printing or laser deposit welding)
Marketing research	
Customer interviews and observations (e.g., monitored test markets)	Structured observation of customers (e.g., in the context of a video-monitored test market) or the conduct of interviews with customers (e.g., personal, on-site interviews or questionnaire-based telephone interviews) with the aim of identifying and better understanding what customers need/want
Product (design) test (e.g., home-use tests)	Getting customers to try out products, e.g., in the context of home-use tests (where a product is supplied to customers who subject it to everyday use and provide feedback on their experience of the product) or product design tests (e.g., by demonstrating and evaluating different product designs)
Price test/price sensitivity analysis	Method of determining the ideal price or price range
Conjoint analysis	Market research method to identify the importance of individual product functions. To this end, several different combinations of products are showed to the test person and evaluated (comparison of pairs)
Purchasing	
Target costing	Calculation of the maximum cost of a product or component in light of its market price or target price (or how much the customer has been found to be willing to pay)

(continued)

(continued)

Method/approach	Description
Specified tenders	Eliciting of tenders from several suppliers based on detailed product specifications for each component that adds value and that must be purchased in order to manufacture the new product
Total cost of ownership (TCO)	Calculation of all costs, from the development of a product to its withdrawal from the market (e.g., including downstream costs for the spare parts provisioning)
Low-cost/best-cost country sourcing (L/BCCS)	Systematic sourcing in countries with low labor costs (e.g., in Eastern Europe)
Quality and logistics	
Supplier management and development	Direct intervention in the activities of suppliers and/or direct support for suppliers' operations with the aim of improving suppliers' skills and performance
Design for six sigma (DFSS)	Quality management method with the aim of achieving zero-defect products and processes wherever possible
Failure mode and effect analysis (FMEA)	Analytical method used in reliability engineering with the aim of identifying and evaluating potential weaknesses in a product at an early stage. To this end, potential sources of defects are weighted and assessed. This form of risk analysis is intended to identify and eliminate potential defects before they materialize
Project management	
Critical path analysis	Project milestone planning ("who is to do what by when?") in which individual steps are coordinated and the "critical path" is defined (delays in these project steps lead to delays in the overall project)
Product value/profitability analysis (break-even analysis, net present value, return on investment)	Structured project feasibility analysis, e.g., based on a break-even analysis or on the return on investment
Project controlling (time and budget)	Regular project controlling to ensure that deadlines and budget targets are met and to monitor compliance with project milestones (e.g., by designated project controllers)
Project risk controlling/project risk matrix	Visualization and monitoring of project risks (e.g., delays and quality considerations)
Common methods	
Creativity techniques (brainstorming, brainwriting, mind mapping, synectics, etc.)	Methods deployed to find creative solutions, e.g., intuitive methods (such as brainstorming) and discursive methods (based

(continued)

(continued)

Method/approach	Description
	on logical reasoning sequences, such as morphological boxes)
Benchmarking (competitive intelligence)	Structured comparison with both in-house products and products (or solutions) made by competitors
SWOT analysis (strengths, weaknesses, opportunities, and threats)	Structured juxtaposition and analysis of the strengths, weaknesses, opportunities, and risks associated with a product or a possible
Scenario planning and analysis	A method of strategic planning designed to analyze the scope of potential events and their impacts (e.g., best-case, worst-case, and typical-case scenarios)

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